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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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Paris Conference and Exhibition.

When making a casting, three operations are necessary—the preparation of the pattern, the moulding, and its actual teeming. So, too, in organising an international foundry congress, similar processes have to be carried out. At the moment, the pattern, though only of the skeleton variety, is complete. Such a pattern is very difficult to make and requires much co-operation, as it is being made in three widely-separated countries having different standards. The American Foundrymen's Association have submitted two alternative schemes to their members, the first of which allows visitors to spend 17 days in England, and the second, 10 days. During this period they are to visit the Sheffield, Birmingham, Manchester and London areas, where they will be received by the various branches of the Institution of British Foundrymen. On September 12 they are to travel to Paris with the British contingent. The skeleton arrangements for this have been modified to meet the wishes of the French Association. Thus it has been decided to travel by the short sea route, leaving Victoria by the afternoon train. This will give ample time for all English members to leave their districts that morning, but for the Scotch it will involve leaving the day before or travelling overnight. The return will be made on the following Sunday, September 16. The balance of the pattern made in France is now fairly complete. The conference is to be opened on the Wednesday by a Cabinet Minister, when the Ecole des Arts et Metiers will be visited. Special visits to places of interest in Paris are being arranged for the ladies of the party, and a feature of the congress is that each day lunch will be taken in different restaurants, where everybody can meet. For instance, on the Friday, the Eiffel Tower is to be the rendezvous, where special facilities will be afforded to see the machinery.

The Saturday is to be devoted to the social side. It is to take the form of an excursion by boat to St. Germain. Lunch will be taken on board "Le Touriste," and the forest and castle will be visited. In the evening a banquet will be held in one of the large hotels.

After the Congress is over, two additional excursions, mainly for the benefit of the American visitors, are being arranged. The more important one is to embrace Nancy, Pont à Mousson, St. Mihiel, Verdun, Metz, Liège, Brussels, Lille, and so back to Paris. This will occupy about a week, and the British visitors will return to London on Wednesday, September 26. The second visit will be to the centre of France, and will only occupy two or three days.

It is hoped that a preliminary circular will be in the hands of both members and foundrymen in the course of a few days.

In dealing with this subject on previous occasions we have appealed directly to foundry owners to extend their most cordial support to the scheme. No foundry has a monopoly of knowledge, and the international exchange of views may quite easily provide some method or means which will bring to the owners a very good return on the small investment required to go or be represented in Paris.

Iron and Steel Output in February.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in February totalled 543,400 tons, or 24,500 tons less than in January, mainly owing to the smaller number of days, for the average daily output was about 6 per cent. higher than in January. The production included 174,000 tons of hematite, 184,800 tons of basic, 125,900 tons of foundry, and 30,300 tons of forge pig-iron.

The output of steel ingots and castings in February totalled 707,100 tons, which is the highest output attained since December, 1920, and is higher than the average monthly production in 1913. The amended figure for January, 1923, is 634,100 tons.

French Scrap for Belgian Coke.—The French and Belgian Governments have just come to an agreement relating to the long-discussed exportation of French scrap iron and steel to Belgium in exchange for Belgian coke. Belgium agrees to allow 30,000 tons of metallurgical coke to pass her frontiers each month in return for which France will allow the export to Belgium of 15,000 tons of scrap iron and steel per month.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Volume Changes of Cast Iron on Solidification.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The detailed reply by Mr. Smalley to questions raised by his Paper on the above subject, coupled with the desire expressed at the end of his letter, will, I hope, lead to this fascinating and important subject being discussed still further for the mutual benefit of all concerned.

There is certainly a need for more investigation to be made into what Mr. Smalley describes as the four problems of liquid shrinkage, considering these as suggested, first separately and afterwards generally. In this way the subject will be placed on a sounder and more scientific foundation.

I agree fully with the statement that hot metal is essential to the production of clean castings, the degree of heat necessary depending, as stated, on the nature of the particular iron in use. It is always wise, in the case of work which has to be machined, to melt hot and allow the metal to cool somewhat in the ladle if a lower casting temperature is required, rather than to melt dull and cast direct. The table in the Paper which gives the analyses and freezing temperatures of various irons confirms the variation in the freezing ranges, and is of value in this connection. I can also confirm the statement that sulphur prints are useful for determining whether the pouring temperature of a defective casting was satisfactory or not.

Mr. F. J. Cook's letter K test is also useful in the foundry as a check on and a guide to correct casting temperature.

Mr. Smalley hopes to produce "a series of curves which will express in seconds the minimum time figure during solidification necessary to produce a certain degree of solidity with the commoner grades of cast iron when poured with different degrees of superheat."

These curves should be very helpful, as there is room for considerable research in this direction. This investigation should also throw more light on the possibility of producing a fine grained graphite in cast iron of ordinary quality which is desirable on account of its effects on the strength, solidity and machineability of the castings.

Mr. Smalley's work is in the right direction, and he is to be congratulated on his Paper, as is also the firm with which he is connected for their willingness to pursue this line of investigation and for their consent to the publication of the results obtained.—Yours, etc.,

ERNEST WHEELER.

Princess Street, Manchester.

March 17.

Catalogues Received.

MESSRS. WADKIN & COMPANY, North Evington, Leicester. A brochure dealing with combined surfacing and thicknessing machines.

Probably the most interesting feature of this booklet is the section devoted to taper planing. To accomplish this Messrs. Wadkin have designed a machine which allows the front surfacing table to tilt for taper planing. This enables the pattern-maker to obtain the necessary draft straight from the machine. The table is pivoted at the back side, and the desired amount of taper is given by the ordinary cutter block spanner engaging in a screw nut recessed into the surface of the table at the front side, a scale indicating the amount of taper required. It is interesting to note that no special fixtures or attachments are required, and the machine can almost instantaneously be set to give any desired taper. When not being used for taper planing the table is locked down on a machined surface by means of the screw nut mentioned.

MESSRS. G. F. VAUGHAN, E. VAUGHAN, and A. H. VAUGHAN, brassfounders, Pioneer Works, Willenhall, trading under the style of Joseph Knowles & Sons, have dissolved partnership.

Institution of British Foundrymen.

Newcastle Branch—Junior Section.

The second general meeting was held on March 8, when the President, Mr. H. F. Clements, read a Paper on "Cast Iron—from Ore to Casting."

The lecturer dealt successively with the distribution and nature of iron ores. Their classification, chemical composition, preparation and smelting were described. The advantages of hot and cold blast, fluxes and fuel were touched upon. Foundry pig-irons and a description of the cupola concluded an interesting address. An excellent discussion followed, in which Messrs. H. C. Jay, S. D. Blenkinsop, E. J. Rang, Bell, Van der Ben, Patterson, Tunnah, Gospel and Howe took part.

Book Review.

THE MODERN IRONFOUNDRY.—By Joseph G. Horner, A.M.I.Mech.E. Published by the Oxford Technical Press, 1 and 2, Bedford Street, London, W.C.2.

Perhaps, of all writers on foundry work, the author of this book is the most prolific, and has undoubtedly done much to classify and correlate foundry operations. There are no revolutionary ideas enunciated, the orthodox having been religiously followed throughout. This renders the work especially useful for the apprentice or journeyman, as it is advisable that the orthodox should be assimilated before consideration is given to debatable questions. The book is not ideal to our mind, as a treatise on the modern ironfoundry should contain some elementary metallurgical conclusions. Moulders should know something about the elements which go to make up cast iron, and what their variation signifies.

The book is divided into eighteen chapters, and is illustrated with 146 diagrams. The chapters deal successively with iron and testing; cupolas and their working; fans, blowers, fuels and ladles; sands; moulders' tools; methods of moulding; examples of moulding; the former in foundry work; machine moulding; permanent moulds; die castings; faults in castings; runners and risers; calculating the weights of castings and the design and equipment of a modern foundry. We do not care for the arrangement of the design of foundry, the author has shown especially the arrangement of the fettling room, which comes to almost a dead end, in place of allowing material to enter at one end leave by the other. The book, as previously mentioned, is essentially orthodox, and as such can be placed in the hands of any student, and the work outlined in it is seldom controversial, and thus forms an excellent jumping-off ground for the average foundryman.

Space at the Paris Exhibition.—The Organising Committee of the Association Technique de Fonderie are now in a position to allocate space for the forthcoming International Foundry Trades Exhibition, to be held at the Ecole des Arts et Metiers from Sunday, September 2, until Sunday, September 16. They have adopted a uniform price of 90 francs per square metre, except for a few larger spaces in the large hall, for which 110 francs is required. Firms interested should write for particulars to Monsieur le Secretaire, L'Association Technique de Fonderie, 15, Rue Bleue, Paris, IXe.

Grants to Research Workers and Students.—The Department of Scientific and Industrial Research have issued a pamphlet relating to this subject, in which it is stated that the grants to individuals which the Department is prepared to make on the recommendation of the Advisory Council for Scientific and Industrial Research fall under the following headings:—(*a*) Maintenance allowances to students to enable them to undergo training in research; (*b*) personal payments to investigators to enable them to devote the whole or part of their time, either to their own research or to collaboration with a professor or other qualified person in the development of a research in which he is interested; (*c*) provision of laboratory, clerical or other assistance to research; (*d*) grants for special equipment and other special expenses incidental to research. Details relating to these heads are contained in the pamphlet, which can be obtained from his Majesty's Stationery Office, Kingsway, London, W.C.2.

Machine Moulding Methods.*

By T. F. Hardyman.

In examining foundry methods of production it is not necessary to go back many years to find crude and clumsy methods employed, largely on account of the mistaken ideas which owners formerly held. It will be generally agreed that fifteen or twenty years ago, whilst firms were prepared to spend considerable sums of money on the equipment and organisation of their machine shops, they were particularly careful to spend as little as possible on the equipment and organisation of their foundries.

This was probably due to the fact that engineers in general had but a slight acquaintance with foundry practice, and also to the fact that the majority of foundrymen in those days lacked the knowledge, ability or the initiative to develop and put forward schemes for the economical production of sound castings. As a result, patterns from which large quantities of castings were required were usually mounted in the form of cheap, rough pattern plates or oddsides for quicker production. Even this method of moulding was confined to very simple work, and anything resembling an intricate casting was usually carefully produced by a skilled moulder.

There are, however, other very important advantages and benefits to be derived by the installation of machinery in the foundry in addition to that of producing castings more cheaply, as the castings produced from a moulding machine, properly equipped, are uniform in shape, with uniform machining allowance and freedom from many of the defects, usually found in castings, *i.e.*, scabs and blow-holes. Engineers will readily appreciate the importance of uniformity of shape, which facilitates jigging without trouble, also the uniformity of machining allowances, which enables machining operations to be planned and timed accurately, thus obviating the vexing necessity of allowing special times and bonuses on troublesome castings. Freedom from scabs also eliminates the troublesome sand patches often found in badly moulded castings, which ruin the cutting edges of tools, causing a breakdown in the sequence of operations and dislocating the flow of work in the machine shop. These are very important factors indeed, but the author is of opinion that even to-day the extent to which machine moulding can minimise these troubles is not sufficiently appreciated.

Cheap Patterns Not Economical.

It is common practice for engineers to have patterns produced as cheaply as possible, having little or no regard to the extra expense incurred in the foundry in producing castings from such patterns. There are cases where, to save a pound or thirty shillings on the first cost of the pattern, engineers have ultimately been compelled to pay considerably more for their castings than they would have done had they supplied the foundry with properly made patterns, carefully laid out and prepared for economical production. Indeed, the extra cost of producing castings from cheap patterns, even where quite small quantities are required, very frequently amounts to considerably more than the original cost of such patterns.

The author has frequently been asked what type of moulding machine he considers to be the best on the market, and has found it extremely difficult or impossible to give a satisfactory answer, as questions of this description regarding moulding machines are equivalent to asking an engineer what are the best machines to have in a machine shop. *The type of machine, of course, depends upon the design and character of the castings that are to be produced, whether intricate or simply light or heavy, deep or shallow, and whether small or large quantities are required.* The equipment of a foundry with moulding machines requires the same consideration as the provision of the various types of machines necessary for machine shops. In some foundries pneumatic machines give the best results, because of the peculiar circumstances under which the castings have to be made, and perhaps because of the particular character of such castings, *i.e.*, in foundries which can be described as of the jobbing type, where very small quantities are required and the patterns belong to customers. In other foundries hydraulic squeeze machines are undoubtedly the best, especially where large quantities are required from a given pattern.

The opinion is strongly held in some quarters that the jar machine is the best for deep castings. This view is a questionable one, as deep castings can also be produced quickly and satisfactorily on a hydraulic press machine; it cannot be denied, however, that where exceptionally deep castings—say, for example, a 9-in. diameter pipe 9 ft. long and moulded on its end—are required, the jar machine is desirable, but the exception must not be taken for the rule.

Cost of Pattern Plates.

Some years ago the author found that one of the greatest difficulties in introducing machine moulding into the foundry was the cost of preparing pattern plates and moulding boxes with sufficient accuracy to give satisfactory results. The cost of these was such a very serious matter that it became obvious that if machine moulding were to be a success it was essential that the foundry be made as independent as possible of machine shop assistance in the production of pattern plates, patterns, and machining and drilling of moulding boxes. After devoting a considerable amount of attention to these points, the author succeeded in making the foundry almost entirely independent of machine shop assistance in this direction.

Figs. 1, 2 and 3 illustrate roughly the manner in which an engine bearing cover would be produced on a jar-ramming machine, and an attempt has been made to show the varying density of the sand in different parts of the mould as the result of jarring. It will be apparent that the jarring of the machine jolts the sand more closely together at the bottom of the moulding box than at the top, so that when the top of the box is reached it is usually necessary thoroughly to ram the sand by hand. This point assumes greater importance when it is considered that the top of the moulding box on the machine is generally the bottom of the mould in casting, and unless the ramming of the mould is finished by hand in this manner a distorted casting is the result, owing to strains in pouring and the inability of a soft mould to resist such strains.

The pattern plate used on this machine will be found upon examination to be fairly expensive to make, as the recess shown below the joint line of the mould would in this case need to be machined out of the solid plate. The boss would then be located and secured in the centre of the recess, and the radii around the supporting ribs carefully fixed to the plate. As a matter of fact, the construction of a pattern plate of this description is a somewhat complicated proposition, and, in spite of the expense, it will be found necessary to core out the centre or bore of the casting with a dry sand core, as shown in Fig. 3. The moulding box employed is 13½ in. by 17 in. by 7 in. deep, and usually takes 1½ minutes to make up one half-mould on a jar machine. This represents, roughly, 191 complete moulds per day on a continuous production basis of 8½ hours.

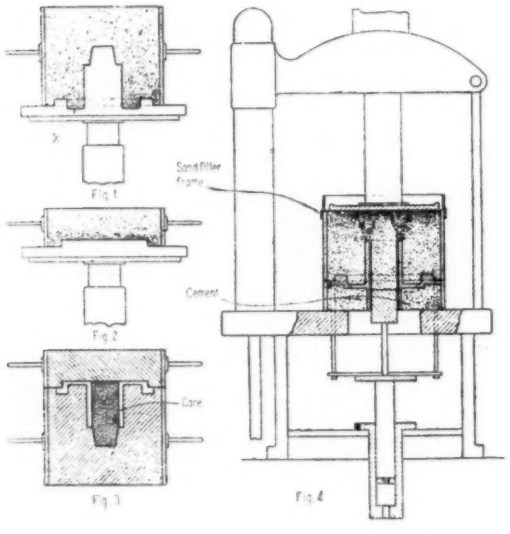
In arriving at the cost of a casting produced on a jar machine in this manner, in addition to the cost of the labour engaged on making the mould, the cost of making the core, transporting it to the mould and fixing it in its correct position must all be taken into account. The cost of the compressed air used for operating the machine, plus the high percentage of loss usually associated with compressed-air moulding machines, must also be added, whilst the rate of depreciation and cost of maintenance of the moulding machine is still another item.

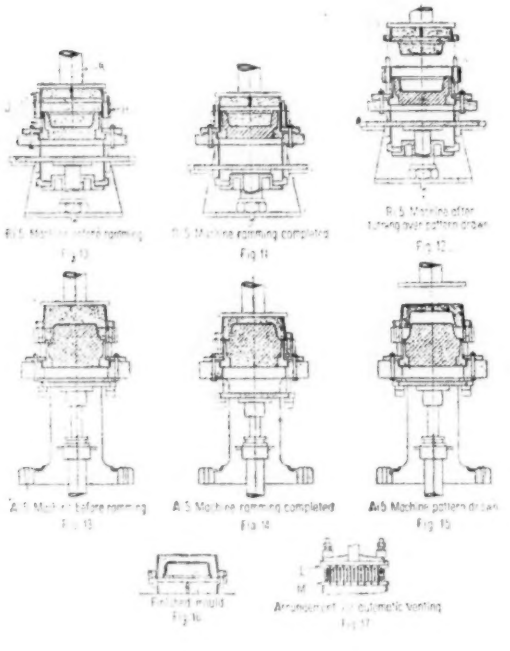
C

* A Paper read before the Institution of Production Engineers on February 23.

Squeezer Machines Require Varying Sand Fillers.

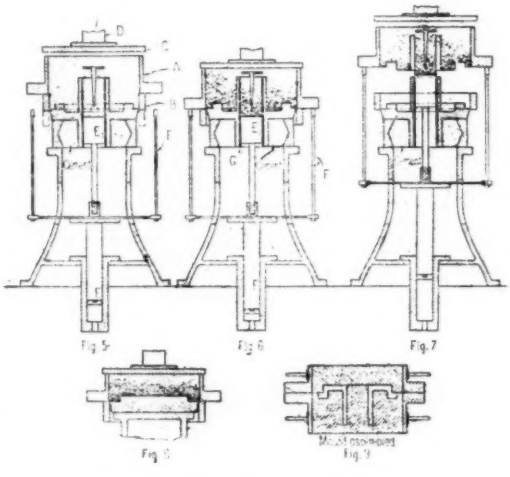
In Fig. 4 is shown the method of producing the same casting in the ordinary manner on a hydraulic machine. It will be observed that the arrangement of the pattern plate, moulding box, etc., shown is somewhat different from that usually adopted on power-operated pressing machines. It is the usual practice on machines of this description to fill the moulding box with sand and then to place a sheet-metal frame around the top of the box, which is also filled with sand. This frame is supposed to measure the sand that is to be pressed into the box by the press plate of the machine. Only one sand filler is usually found with each machine; this, in the opinion of the author, is responsible for most of the trouble experienced with moulds produced on a squeeze machine, as it is obvious that a pattern which nearly fills the moulding box does not require so much sand as a pattern that occupies a very small amount of the space available in the box. Further, with the use of a standardised sand-filler-frame on the top of the moulding box in this manner, sand is likely to be squeezed much more tightly between the top of the pattern and the press plate at the points indicated in the illustration than at the bottom, where it is in contact with the pattern plate. This can be obviated by judiciously removing a certain amount of the sand from the filler frame before squeezing the mould, and when this is done satisfactory results are obtained, although, as shown in the illustration, the pressure is applied to the sand in the top of the box, which is consequently harder than the sand in the bottom of the box, *i.e.*, the sand on the face of the pattern. This is likely to cause an unsound casting, as it allows the gas to escape from the face of the mould, to be ultimately trapped at the back of the mould, where it should really be free to escape.





Importance of Down Sand Frames.

The next illustrations, Figs. 5, 6 and 7, show what the author considers to be the ideal method of producing this casting, both from the point of view of cheapness and in producing a perfectly sound casting. It will be observed that this arrangement is furnished with what the author terms a downsand frame, B, which takes the place of the sand-filler-frame used on the top of the box in the method previously described. The essential difference between the frame used on the top of the box and the one employed at the bottom is that by the use of a top frame pressure is applied to the mould at the top, whereas by the use of the downsand frame it is applied at the bottom of the mould, or on the face of the pattern. Furthermore, the downsand frame shown at the bottom of the moulding box can be adjusted to varying depths, which is a very important point, as will be seen later. The use of these downsand frames gives the ideal conditions which are necessary to obtain a first-class casting.



It will be observed that the downsand frame in Fig. 5 is somewhat higher than the actual joint line of the pattern plate, the actual distance between the pattern plate and the top of the down-sand frame being decided by the amount of sand it is found necessary to compress to secure the correct degree of hardness in the mould. This having been once ascertained, the downsand frame is secured permanently in the required position, so that all subsequent moulds will be of the same degree of hardness as the first. This is a very important factor in the production of castings, as any foundryman will agree, since it ensures uniformity in shape and facilitates jigging of the castings, as well as uniform soundness so far as blow-holes and scabs from hard moulds are concerned.

The downsand frame carrying the moulding box itself is supported on two small hydraulic cylinders or springs (not shown, and the cycle of operations is to place the box A on the frame B, fill with sand and scrape off level at the top of the box, and then apply the pressure by the press plate C, which is attached to the hydraulic ram D. This pressure overcomes the resistance of the two small hydraulic cylinders or springs carrying the down-sand frame, and the pressing ram completes its predetermined stroke, as shown in Fig. 6. From this illustration it may be seen that pressure is exerted on the sand in the moulding box at the bottom, whilst it will be apparent that no hand-ramming whatever is required.

Further, on this machine the core forming the bore of the bearing cover is made at the same time as the mould, and leaves the machine as an integral part of the mould, although the core is perfectly parallel. This core is 2½ in. in diameter by 5 in. long. Fig. 6 shows how it is possible to make the core at the same time as the mould. The hydraulically operated plunger E occupies the position shown while the mould is being pressed with the main ram D. When the main ram has travelled the full extent of its predetermined stroke, however, pressure is applied by the ram E, the stroke of which is also determined by the four lifting arms F. The main press-plate now recedes, and is followed up by the mould, carried for the first stage of its travel by the downsand frame, assisted by the plunger ram E and the lifting stools F. When the downsand frame has returned to its original position the four lifting stools and the plunger ram E continue to lift the mould until it is clear of the pattern, as shown in Fig. 7.

In Fig. 8 the method of making the top part for the mould is shown, and Fig. 9 illustrates the mould assembled for casting. The time occupied in making a half-mould by this method is also

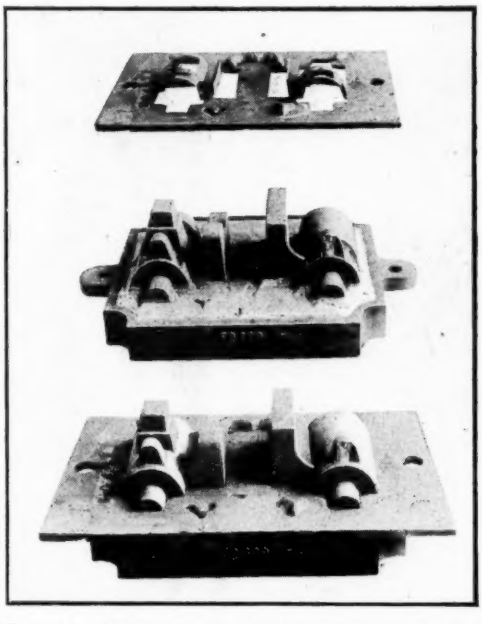


FIG. 18.—PATTERN AND STRIPPING PLATES FOR AN ENGINE SIDESHAFT BRACKET.

1½ minutes, representing 191 complete moulds per day on a continuous production basis of 8½ hours.

From Figs. 6, 7 and 8 it will be observed that the density of the sand in the mould made on the hydraulic machine is much more uniform than in a mould made on a pneumatic jar machine. The slight variation in density indicated is an exaggeration purposely made to show where the mould is most likely to be soft; this allows the gas to escape from the mould in the correct manner. It should be mentioned that the pattern plate shown is made entirely by a moulder in the foundry, with the exception of the small plunger E1 and the bush G, these two parts being prepared in the machine shop and embodied in the pattern plate by the moulder.

This bearing cover casting is by no means regarded as difficult. It would be possible to show far more intricate castings, such as those for water-jacketed cylinders moulded in precisely the same manner, but the bearing cover was selected as affording the best illustration of the principles of the three different methods of machine moulding.

The pattern plate employed in the last method on the hydraulic machine may appear to be somewhat complicated and expensive, but actually this is not so, because the making of the pattern plate is a fairly simple operation when a skilled moulder has had a little experience. To make the plate the moulder first prepares a mould from his master pattern and then stands the bush G in position, afterwards pouring the casting with a special mixture of white-metal. The metal pattern thus made is left in the bottom part of the mould and the upper surface brushed off clean. A cement frame is then placed over it and filled with cement in the afternoon, so that on the following morning, when the cement has set, the frame and the pattern become one, and can be removed, and the whitemetal pattern easily and quickly prepared for use the same day.

Comparative Costs.

The following are comparative figures for a mould made on the pneumatic jar machine and a mould made on the hydraulic machine fitted with downsand frame:—

Jar Machine.

	Time. Mins.	Secs.
Making complete mould	3	0
Coring up	0	5
Core making	4	0
Transportation of core	3	0
Total	10	5

Taking power at 1.75d. per h.p. hour, 50 h.p. compresses 16,500 cub. ft. of free air per hour at a pressure of 80 lbs. per sq. in., at a cost of 0.005d. per cub. ft. Thus, with an estimated consumption of air by the machine (including losses) of 9 cub. ft. of free air per complete mould, the power cost is 0.045d. per mould.

Hydraulic Machine.

	Time. Mins.	Secs.
Making complete mould (both parts) with core integral part of mould...	3	0
Total	3	0

In this case, taking power at the same figure, 7 h.p. per hour gives 1s. 0¼d. for 450 galls. of water at 750 lbs. per sq. in., or 0.027d. per gallon. Thus, since the machine consumes 6 pints of water for a complete mould, the cost is 0.02d. per mould.

From this it will be seen that it takes 236 per cent. longer time to make a complete mould on a jar machine than on a hydraulic, whilst the power costs are 125 per cent. greater for a mould made on a jar machine than for one made on a hydraulic unit. The saving, therefore, obtained by the use of a hydraulic machine in preference to the pneumatic is very considerable.

Pattern Considerations.

With regard to the pattern required for use on the jar-ramming machine when a large number of castings are to be made, it is not possible to make the pattern plate in the same manner as that employed on the hydraulic moulding machine, as the jarring of the machine would rapidly cause the cement to break up. There is accordingly no alternative but to revert to the old method of pattern plate making when the jar machine is used. By this method a cast-iron plate must be machined on both sides and carefully marked off for locating the pattern and the moulding box pins, after which several trial castings are made to ascertain whether the marking off of the pin centres is in correct relation to the pattern. Furthermore, it is usually necessary when a metal pattern is required for this to be made in brass or iron, which is more expensive to finish off than the white-metal pattern used on the hydraulic machine.

With the pattern plate for a hydraulic moulding machine no marking off is necessary, as the pattern is cast in one of the boxes in which it is intended to make the castings, and the pin holes on the plate register with the moulding boxes; it necessarily follows that the centres are bound to be correct, and cross-jointed castings cannot possibly result.

One or two further examples of hydraulic machine moulding may now be considered.

Figs. 10 to 17 show the manner in which a cast-iron pan is made on a hydraulic turnover machine fitted with a downsand frame, the arrangement being very similar to that for the bearing cover, though more details are given. It will be noticed that the downsand frame H is guided by extended

box pins J, down which it slides when pressure is applied by the ram K. Fig. 10 shows the bottom part of the moulding box mounted on the machine and filled with sand ready for pressing on a turnover machine, whilst Fig. 11 shows the position of the bottom part of the box after pressure has been applied. In Fig. 12 the machine is shown after it has been rotated and the bottom part of the mould withdrawn from the pattern plate by the receding ram.

Fig. 13 shows the top part of the moulding box in position on a machine which does not rotate, the box being filled with sand ready for pressing, and Fig. 14 shows the top part of the box after pressure has been applied. The top part of the mould, lifted clear of the pattern, appears as shown in Fig. 15, whilst Fig. 16 shows the mould assembled ready for casting.

As it was found desirable to vent these moulds, this was done in the manner indicated in Fig. 17. The arrangement consists of two pressplates, L and M, which are held apart by springs, and in the top plate vent wires are fixed which pass through the holes provided for them in the plate M. In operation, when the pressplate M comes into contact with the top of the moulding box its progress is temporarily stopped, but the pressplate L still continues down, with the result that the vent wires enter the sand in the moulding box before the final pressure is applied to the sand. When the pressure of the ram is withdrawn the pressplate L, to which the vents are attached, commences to recede first, the pressplate M remaining stationary and acting as a stripping plate for the vents until the plate recovers its original position. It then continues to rise with the receding ram until clear of the moulding box.

In a boxless hydraulic moulding machine, the pattern plate is a double-sided one carried on the arm brackets situated near the centre of the back columns, and the cycle of operations is as follows:—A board is placed in the bottom part of the machine flask, which is then filled with sand and scraped off level, after which a coat of facing sand is sifted on the top of the black sand and the pattern swung round into position over the bottom part. The top flask, which is also part of the machine, is placed into position upon the pattern plate and sand sifted in in the usual manner, when the head-stock of the machine is pulled over and hooked in position and pressure applied, both the top and bottom part of the mould being made simultaneously. As the pressure is removed from the ram it recedes, and the patterns are withdrawn from both the bottom and top parts of the mould simultaneously and the pattern plate swung out of position. The ram then travels up again and forces both the bottom and top parts of the mould clear of the permanent moulding box, which is part of the machine.

The output of moulds on this machine is about 25 per hour, the permanent flasks belonging to the machine being 17 in. long by 14 in. wide.

A casting for an electric motor end cover bearing may be cited as another example in which the mould is produced on a turnover machine. The pattern plates for this casting are built in a similar manner to that previously described for the bearing cover pattern, and the plate consists of a moulding box in which the metal pattern is located by cement or plaster of Paris.

Fig. 19.—General View in Westland Foundry.

In Fig. 18 is shown a pattern plate provided with a stripping plate for an engine sideshaft bracket. It will be observed that the stripping plate runs all round the difficult parts of the pattern where trouble would be experienced in getting the sand to lift. With this stripping plate, although the lifts are deep ones, it is impossible to damage the mould or to produce one that requires repairing by hand. It will be noticed that the joint line runs up and down where necessary. It would be almost impossible for a plate of this description to be made and built up in a machine shop, and if it were done the cost would be enormous, probably about £100, whereas the plate can be made in a foundry for less than £5, including all labour and materials. Thousands of castings have been produced with the aid of this plate, which was made twelve years ago and is in excellent condition. A noteworthy feature is that both the top and bottom parts of the complete mould are made from the one plate, although the two parts of the casting in the mould are different. A plate of this description could not be used on a jar machine which is confined to level joints.

A view in Westland Foundry showing a number of hydraulic machines employed on producing

water-jacketed cylinder castings is shown in Fig. 19. Six men employed on two machines will produce 120 cylinder castings per day, each cylinder weighing about 1 cwt.

Conclusions.

While there is undoubtedly scope both for pneumatic jarring machines and hydraulic squeeze machines, the respective applications are of a very different character. The author regards the jar machine in the nature of an auxiliary to hand moulding, because very few moulds are made on such machines which do not require a certain amount of hand work in the form of ramming and scraping off.

There are, of course, pneumatic machines which produce the moulds by squeezing instead of jarring, but the pressure obtainable on a pneumatic squeeze machine is very low per square inch of the surface of the mould; consequently, only extremely light castings can be produced satisfactorily on such machines. It must not be forgotten, however, that the jar machine renders valuable service in that it provides a certain amount of mechanical assistance for the moulder in making a mould that would otherwise have to be made entirely by hand, as in the case of a three- or four-part mould for a motor car engine cylinder.

In dealing with the general run of engineering castings that are to be machine-moulded, the author considers that 95 per cent. are suitable for being produced on a hydraulic moulding machine, and if the quantity required justifies machine moulding at all, they should be produced on this type of machine.

From the foregoing remarks, it should be clear that where an intensive production of castings by machine moulding is to be considered hydraulic machines properly equipped are the best, but in a foundry where machine moulding is done spasmodically on small batches of castings the jar moulding machine will render useful service.

Volumetric Determination of Sulphur in Pig-Iron.*

The evolution method is not to be regarded as always yielding the exact sulphur content of the iron. This fact should be given due cognisance by all users of pig-iron. However, it meets better than any other method the time requirements of the iron laboratory, and, when all conditions in connection with the sampling and analysis are properly controlled, it is sufficiently reliable to satisfy the demands of the various metallurgical processes in conjunction with which it is employed.

The apparatus recommended for this determination consists of a 300- to 500-c.c. flask; a two-hole rubber stopper carrying an ordinary funnel or thistle tube and a glass exit tube bent at a right-angle; a delivery tube, also bent at a right-angle; and some suitable form of absorption vessel. The exit and delivery tubes are connected with sulphur-free rubber tubing, and the latter is inserted into the absorption vessel in such manner as to conduct the evolved gases to the bottom of the vessel. The absorption vessel may be either a tall form beaker of 500 to 600 c.c. capacity, in which the titration is later conducted, or a test tube, preferably 10 in. by 1 in., suitably supported.

A minimum of 2.5 grammes or a maximum of 5 grammes of the sample is transferred to the flask, the stopper is inserted and the flask is connected with the absorption vessel. Ten to twenty cubic centimetres of the absorbent solution are added to the absorption vessel and diluted to 60 c.c. or 200 c.c., depending upon whether a test tube or beaker is employed. Forty to sixty c.c. of hydrochloric acid (1:1) are introduced into the flask through the funnel, and heat is applied so that a brisk evolution of the gases is maintained until the sample is decomposed. The temperature is then raised until the steam formed has forced the last trace of hydrogen sulphide gas into the absorbent, as indicated by a marked rise in temperature of the delivery tube above the point of entering the absorbent solution. The apparatus is disconnected and the titration is conducted as described below.

Ten c.c. of starch solution are added to the beaker in which the titration is effected, and the contents of the absorption tube are transferred thereto. The absorption and delivery tubes are rinsed with cold water, which is added until the beaker contains at least 300 c.c., when any adhering precipitate is dissolved by means of a fine jet of hydrochloric acid (1:1). If the absorption is effected in the beaker the delivery tube is removed and cleansed with acid and water. Then a slight excess of hydrochloric acid (1:1) is added. The final volume of the solution should approximate 400 c.c. The solution is stirred gently in order to neutralise the alkali of the absorbent, but care is exercised that the liquid in the beaker be not unduly agitated before the introduction of the standard iodate solution. The standard iodate solution is then added in successive portions, while the solution is stirred as the colour fades, until the addition of the final drop yields a permanent blue colour of the adopted end point. The number of c.c. of the standard iodate required multiplied by 0.01 is equivalent to per cent. sulphur.

Solutions Required.

Standard Potassium Iodate Solution.

Potassium iodate ...	1.12	grammes
Potassium iodide ...	12	grammes
Potassium hydroxide ...	1	gramme
Water to make	1,000	c.c.

The iodate, iodide, and hydroxide are dissolved in 300 c.c. of water. The solution is then diluted to 1,000 c.c. when it is ready for standardisation. A standard steel, the sulphur content of which has been established gravimetrically, is used as a basis of standardisation. With final adjustment so that 1 c.c. is equivalent to 0.01 per cent. sulphur, based upon the initial weight of the sample used, the solution is ready for use. It must be kept in the dark and in a cool place.

Absorbent Solutions.

Ammoniacal Cadmium Chloride Solution.

Cadmium chloride	5 grammes.
Water	375 c.c.
Concentrated ammonia ...	625 c.c.

Ammoniacal Zinc Sulphate Solution.

Zinc sulphate	10 grammes.
Water	375 c.c.
Concentrated ammonia ...	625 c.c.

Sodium or Potassium Hydroxide Solution.

Sodium or potassium hydroxide	5 grammes.
Water	1,000 c.c.

Starch Indicator Solution.—An emulsion of 6 grammes of starch in 100 c.c. of cold water is cautiously added to a litre of boiling water which is contained in a suitable flask. After continued boiling for five minutes, the contents of the flask are cooled, and 6 grains of zinc chloride in 50 c.c. of cold water are added to preserve the solution. After thorough mixing, the flask is set aside for 24 hours with occasional shaking. When the heavier particles have settled, the supernatant liquid is carefully decanted into a suitable container.

It is recommended that the starch be added to boiling water, as this tends to lessen the often unavoidable frothing; should frothing occur, however, its subsidence may be effected by playing a jet of air over the surface of the boiling solution.

If desired, the starch indicator solution may be added to any of the stock absorbent solutions, thus affording the proper amount of indicator in the titrations without adding it separately in each case.

* A method used and published by the United States Steel Corporation.

MR. SAMUEL TAYLOR, of Wellington, Shropshire, the founder of the well-known firm of Samuel Taylor & Sons, Limited, Brierley Hill, Staffs., chain and anchor manufacturers, died last week at the advanced age of 86 years. He founded the firm about 50 years ago. When he subsequently retired the firm was turned into a limited liability company, and Mr. Taylor's son and grandson succeeded him as managing directors.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Test Bars.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I was hoping to raise some little discussion on cast-iron tests, but on reading the current issue I find I am in trouble with your correspondent with regard to a few remarks on gunmetal. It seems to me he has entirely overlooked the real object I was endeavouring to achieve, *i.e.*, for reasonable test for materials as used in foundries, and the points raised about faking test bars were only cited as representative of how foundrymen have overcome tests not in keeping with sane methods. Strictly speaking, it was not faking the test, as they were made from the same material as the castings in question, but to obtain a sound bar was detrimental to the castings, and as the bar was of secondary consideration I made them first. It was not a question that I was not capable of making test bars from gunmetal. This is a very simple job, when there are not other complications, and after some time we adopted methods which enabled us to cast on the bars in the usual way. Would there have been any commonsense in casting perhaps a considerable number of castings to obtain a good test bar?

I make no statement that this applies to non-ferrous foundries generally—this is your correspondent's assumption—but what I insist is that I should not blame any foundryman who faked a test bar to save the scrapping of first-class castings. This was the object I achieved. The casting was as good a job as was ever turned out by foundrymen, and passed through the machine shops and hydraulic test with good results (2 per cent. scrap).

At the same time as the castings mentioned were made we were casting large numbers of a similar class of cylinder all from the same stack of ingots; in fact, it all depended on which mould was ready first. As to the use of the metal on the other cylinders, the bars were cast on, not burned on. The results were to specification, both physical and analytical, and, there was no doubt about the material. The facts were, we were making good castings, which were urgently required, and if left to test bars at that period would have had serious results. It is an easy matter to make a good test bar by itself, but not so when attached to certain castings.

The statement that the "overseer" would not accept a casting unless the test bar was cast in the box requires qualifying. Does he mean poured as part of the casting or cast in the same box with a separate runner? If not cast on, I should say the overseer was allowing some latitude. I myself would like this method of working. I plainly state that test bars should be cast on or off at the option of the foundry concerned.

My remarks also applied to the straight 88Cu : 10 Sn : 2 Zn Admiralty gunmetal, and I had to work to this specification. There was no increasing the Sn content to overcome porosity troubles, and there would be some little difficulty in meeting the 7½ per cent. elongation called for, with a Sn content as high as 13 per cent., as the elongation drops very quickly above 10 per cent., and sound castings can be produced without faking the Admiralty gunmetal specification by adding Sn. I am not in favour of bluffing inspectors, and would much rather say point blank I did not wish to cast the bar on, but from the same pot. I should have no fear of doing this in the presence of any inspector.

The chief trouble is that so many inspectors will adhere strictly to the letter, and not the spirit of the specification, and this is where the trouble commences. Your correspondent has no need to assure engineers that faking is not common practice; many of them know this, and in most cases where faking takes place the engineer knows that the tests are unreasonable, and I have not met many who do not accept the reasoning that a hydraulic test is the most severe for any casting, disregarding the "test bars." Your correspondent must know from his experience that with gunmetal it is possible to obtain results ranging from about 9 tons to 20 tons tensile from the same pot of metal. Would he scrap the whole pot because of the 9 tons or pass it all because of the 20 tons? I suppose he does, as most foundrymen do, if he has a casting scrapped under test break up the casting and make another from the same material. I suppose this is really faking a bad casting into a good one. Surely to draw the same conclusion as your correspondent the material should be rejected, as the test bar was supposed to represent this. The question as to whether I could have found it an "easy matter" to bluff the overseer he was dealing with would depend on which way his back was turned and nothing more.

To conclude, let us have tests from materials, but in keeping with foundry practice and sound castings before "test bars."—Yours, etc.,

MEMBER.

Smelting Glasses.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have experienced a real difficulty in obtaining just the "right kind" of glasses or spectacles for steel smelting. To those engaged in the immediate production of metals and alloys at high temperatures correct vision and protection of eyesight is of first and paramount importance. To the casual observer, a piece of dark, smoked or coloured glass is sufficient for occasional use. Blue, green and even red "goggles" are easily obtainable, and are perfectly suitable for such operations as welding, etc., where protection only is a matter for consideration.

Inquiries amongst "first-hand" smelters engaged in the production of steel, where close scrutiny, combined with the application of sound judgment of "condition" discloses a display of discrimination difficult to understand by the uninitiated, but which embodies the realisation of the necessity for such correct medium of vision as will assist in deciding when the final critical condition which will determine the "tapping time" of a costly charge of steel. The practical issues involved are such as will exonerate the smelter from any accusation of "faddiness," and rightly so. The "dark glasses" of a Bessemer "blower" are, to him, as important and far more useful, practically, as is the spectroscope in the hands of a scientist exploring the flame for spectroscopic phenomena. Size, density and mobility are thus observed, freed from the confusion of intense incandescence. The final moments of the "boil" and "tapping condition" of a Siemens bath are of such importance that "any old glass" will not serve as a medium of vision. It is the eye and brain behind the glass that call for assistance in the finite details, the detection of which depend upon and are embodied in the experience of a lifetime. Bad choice of glass may be taken as a lack of appreciation of the importance of such details, and only the epicures fully realise the dearth of the pre-war, European type of glass so much favoured and demanded by the expert craftsman. Such glass is of a medium dark, nearly neutral, or very slightly tinted type, and is in striking contrast to the cheaper "blue glass" invariably offered by English opticians as the nearest substitute to the correct article. Many workers perforce accept the latter, with a considerable falling off of "judging" power, and consequent dissatisfaction.

When consideration is given to the vast quantities of steel produced in this country, together with the equally vast amount of capital represented, it may be considered only fair to offer an appreciation to the smelter of the importance of his job, his difficulties and his enforced deficiencies, remembering that every "heat" passes under the eye," and is thus judged. It will likewise be understood that any attempt to cater for a long-suffering and worthy class of artisan will bring its own reward.

"SMELTER."

[For the electric process there is the added difficulty of keeping the actinic rays (ultra-violet and infra red) from the eye, as they cause temporary blindness. Chlorophyl glass, if it could be made sufficiently dark, should meet the case, but as far as we are aware no such glass is on the market. Further, if this could be made in Triplex glass a great advantage would be shown.—ED.]

Surface and Internal Defects in Iron Castings.*

Their Relationship, Cause and Cure.

By J. E. Fletcher, M.I.Mech.E., M.I.Brit.F.

(*Continued from Page* 201.)

The groups in an ordinary cast iron of composition :—

Total C 3.5; Si 20; Mn 10; P 1.0; and S 0.10 per cent. may be stated as approximately :—

(*a*) Silico-ferrite, 33.2 to 30 per cent.

(*b*) Iron-manganese-carbon eutectic, 53 to 55 per cent.

(*c*) Carbon-iron-phosphorus eutectic, 13.5 to 15 per cent.

(*d*) Sulphides of iron and manganese, 0.3 per cent.

Each of these constituents has a different density, melting-point and coefficient of contraction, and each has a different capacity for dissolving gases.

The exact values have not been determined, but estimating them from figures given by Howe, Benedicks and other workers for the carbide, silicide, phosphide and sulphide of iron and manganese, the approximations given in Table I are relatively useful.

TABLE I.—*Physical Characteristics of Impurities in Cast Iron.*

		Density.	Melting Pt. deg. C.	Contraction in ins. per ft.
A.	—	7.25	1,400-1,450	0.25
B.	—	7.55	1,135	0.25
C.	—	7.40	950	0.24
D.	Fe S.	—	1,250	0.30
E.	Mn S.	—	1,500	0.25

The contention that such variations in density, melting points and contraction must influence the homogeneity of the cast iron series must be admitted as being sound. The segregation of carbon, phosphorus and sulphur in the upper parts of steel ingots and in the neighbourhood of rising heads in steel and iron castings prove this.

All normal commercial cast irons within the limits :—

C 2.5 to 4.2; Si 0.5 to 3.5; Mn 0.2 to 1.5; P 0.02 to 1.5, and S 0.02 to 0.5 per cent.

If cooled sufficiently quickly from the molten, they are white in fracture, the carbon being all in the combined state. So quenched, the contraction is in the neighbourhood of 0.25 ins. per ft. The dominance of the iron carbide is evident, and it is noticeable that the effect of the presence of constituents having lower contraction coefficients is to cause distortion and rupture in many places.

In practice the case of chilled rolls is graphically illustrative of this antagonism of contraction rates, the outer chilled portion high in combined carbon contracting violently on an interior which shrinks at about half the rate. It is the constant endeavour, therefore, of the roll maker to so adjust his mixture that there is a gradual change from the chill to the grain portion. That is, a graduation in the combined carbon content from the envelope to the axis, so that the differences in contraction rates do not lead to fracture.

In the case of large internal shrinkage cavities there are numerous instances of contraction cracks starting from the walls of the cavities, indicating that wherever excessive segregation occurs the differing rates of contraction in adjacent or intermingled constituents are disastrous and point to severe internal stresses during solidification and cooling. In many grey iron castings the presence of silicon is sufficient to bring about, probably during the solidification of the silicide, the graphitisation of some of the iron carbide. This appears to be coincident with an evolution or liberation of dissolved gas, for a close micro-examination, as Howe has shown, reveals the fact that the graphite is surrounded by a gas-filled envelope, the flake not solidly filling the space which previously was occupied by iron carbide, from the decomposition of which the graphite has resulted. This important phenomenon may explain the low density of grey iron which often in massive castings only weighs from 415 to 420 lbs. per cub. ft., whereas white iron may weigh 475 to 480 lbs. per cub. ft.

It has been stated that the lower co-efficient of contraction possessed by grey cast iron is due to the expansion of the decomposed carbide, graphite, but as can be easily seen, the graphite flakes do not, when raked out of their grooves, show any evidence of great compression. The author inclines to the belief that it is the expansion of the gases in the cells containing the graphite which account for the reduction in the net contraction rates, producing a *cushioning* action throughout the mass which is of great practical benefit. This influence of gases has been stated at such length because it has apparently a great deal to do with the phenomenon of contraction in liquid metal from the casting temperature to that of freezing, and possibly later. There is considerable evidence that the dilatation during recalescence and possibly recalescence itself is influenced by the presence of gases. Baraduc Müller, Baker and others found that during the pumping of gases from hot steel and cast iron the greatest rate of gas escape was during the recalescence periods and during the progress of solidification, the gases liberated from the first constituent to freeze being ejected into the second and so on, until in phosphoretic cast iron the bulk of the imprisoned gases enter the portions of the last to freeze. At such positions porosity, blow holes and shrinkage cavities are usually found, indeed always so, if such areas are not in direct communication with feeding heads.

Before leaving this matter it is interesting to turn to the evidence of the cooling curve in showing how varying contents of silicon, manganese and phosphorus affect the rate of freezing.

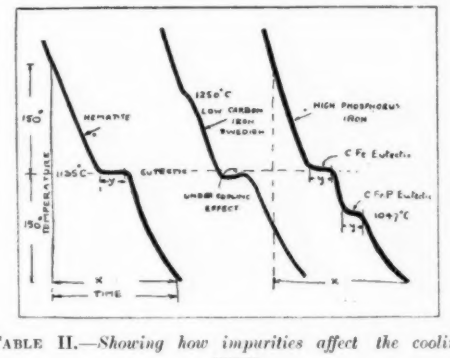


TABLE II.—*Showing how impurities affect the cooling curves.*

P	C	Si	Mn	x	y	$\frac{y}{x}$
—	3.1	3.3	0.1	42	23	0.55
—	3.1	3.0	4.0	45	18	0.40
—	3.6	0.03	0.1	48	27	0.56
—	3.2	0.03	0.1	36	11	0.31
—	2.6	0.06	0.05	36	8	0.22
—	4.2	0.3	0.3	31	16	0.51
1.25	2.8	3.9	0.50	36	13.5	0.38
—	—	—	—	38	14.0	0.36*
1.00	3.5	1.4	0.43	34	12	0.36
—	—	—	—	32	9	0.28*

* 2nd Arrest Point. (Eutectic.)

The author has found that in cast irons, silicon slows down the rate of freezing, whereas manganese quickens it, especially when present above 0.6 per cent. Also that the greater the amount of superheat, the quicker is the freezing. This superheat also introduces the phenomenon of undercooling or suffusion. When such occurs, there is a great tendency to imprison gases liberated so quickly during this rapid freezing period. The rate of freezing appears to be related to the rate of contraction as revealed by the cooling curves.

* A Paper presented to the Sheffield Branch of the Institution of British Foundrymen, Dr. T. Swinden in the chair.

SUMMARY.

It has been shown that cast iron is far from homogeneous in the critical sense. It is not a perfectly liquid metal as it leaves the blast-furnace, and after re-melting in the cupola it is subject to still greater influences preventing homogeneity. Further, even in a portion of metal possessing uniform chemical composition, it is clear that each of its constituents behaves differently in respect to diffusibility, because of the different densities, viscosities and capacities for dissolving gases. As a result, segregation of the lighter constituents persists, and, as the freezing points of the various constituents vary, and with them their rates of contraction, it is clear that there must be internal stresses remaining in the neighbourhood of the areas last to freeze, and where porosity is likely to occur. It is to this lack of uniform structure, when in the liquid condition, that cast iron owes its tendency to develop unsoundness, porosity and shrinkage areas at such points in the casting as are the last to solidify. The internal defects in an iron casting are those primarily traceable to the non-homogeneity of the metal, and are due to a number of influences, each of which causes a divergence from the characteristics necessary to the ideally perfect metal.

In the case of steel, the metal best suited to the needs of castings made in sand-moulds is of the freely "piping" character, and this property, as Brinell has shown, is promoted mainly by the deoxidising elements, silicon and manganese, which increase the density of steel by removing the dissolved ferrous oxide, which latter objectionable inclusion leads to carbon monoxide gas formation. Together the imprisoned oxides and gases increase the viscosity and promote unsoundness and non-uniformity of structure. There is no doubt that in cast iron, silicon and manganese, separately and conjointly, primarily help to deoxidise the metal and increase its homogeneity by speeding up the rate and effectiveness of diffusion; but owing to the slow rate of cooling in some moulds the formation of graphite introduces another factor assisting what may be termed secondary segregation, accompanied by a secondary increase of viscosity.

The function of phosphorus undoubtedly is to modify this trouble, but at the expense of a final condition favourable to segregation and to the production of differential contraction throughout the mass, especially in the case where massive slow cooling areas are insufficiently fed.

The skin, or envelope, of every casting being the first to congeal and to shrink away from the mould is subject to the pressure of the liquid metal in the interior, as the pressure of the fluid within a thin vase tends to burst it. Beyond this, as solidification of the interior proceeds, the accompanying expansions all affect the gradually thickening envelope, which, if kept specially hot at any point, such as the junction between three planes, where the sharp sand corner becomes so hot that the metal adjacent is kept liquid whilst the remainder of the casting has become solid and is contracting. If at such a point, or where a thin sand core is imprisoned between thick metal walls, the sand is not properly vented, then the gases escaping from the cores or mould rush into the liquid metal, and seek exit by way of the nearest liquid slow cooling mass, which becomes porous or cavernous as a consequence.

In another type of skin defect the placing of an insufficiently large riser or feeding head too far away from the massive portion it is intended to feed and to act as gas vent leads to a shrinkage on the top surface of the heavy portion, commonly known as a sink hole or depression.

Each of these massive badly-fed areas becomes similar to a heavy bottom run steel ingot poured through a thin runner which freezes before the ingot, in the upper portion of which a cavity of inverted cone type is almost certain to occur. The top surface or crust of such an ingot covering the conical cavity often droops and forms a "draw" or "sink hole."

In cases where the upper crust is kept hot, either by reason of specially hot metal or the imposition of ashes or charcoal, the top crust of the ingot becomes fused and runs down into the cavity, forming the well-known "pipe."

The same thing occurs in castings wherever similar conditions of running and feeding prevail. The dragged or pulled form of defect in the skins of castings is due to the slow cooling of local spots in the neighbourhood of drastic changes from thick to thin sections, where the contraction of adjoining sections proceed whilst the local slow-cooling points at the junction are liquid.

The skin is broken, sand-gases often finding their way at these fusion points into the casting, thus intensifying the trouble. The dragged appearance of such defects is due to contraction. It should be remembered that during the solidification of a thin wall adjacent to a thick, bulky mass the contraction is always towards the heavy section last to freeze, and where two bulky sections are joined together by a thin one the contraction is in the two opposing directions, and as a consequence the stresses set up in the sections are severe, and results in fissuring at the junctions of the thin and thick sections.

The problem of moulding and core-sands obviously is one of great importance in sand consideration, and is much too large a subject to touch upon in this Paper. But it is clear that the gas permeability and heat conductivity of sands and of their resistance to casting contraction strains is of first importance. The fact is that the ideal sand composition is not realised in practice, but it is approximated in many cases where the subject receives the consideration it deserves.

The author hopes that in the delineation of the paths which lead to shrinkage, porosity and draw trouble, it has been realised that all these defects are related and the way pointed out to cure them. By travelling in the direction of so adjusting the compositions of metal that differential rates of cooling and contraction are minimised and freedom from damaging non-metallic inclusions and gases assured. Also in so designing a casting and its pattern, in so preparing the mould and its sand, that the all-important skin of a casting shall be uniformly stressed that the gases escaping from the heated sand shall not enter the metal at any point to its detriment.

Every foundryman knows the difficulties such a study presents, and in the interim between the present day of troubles due to pig-iron, melting process, coke, sands and a host of other causes such as have been outlined in the Paper, there would appear to be a broad field for the activities of the British Cast Iron Research Association, one of whose functions is that of a clearing house for the general problems experienced daily by foundrymen. From such a centre assistance of a progressive and educational nature should emanate, backed up by the results of the necessarily slower-moving researches on the vital problems of producing ideally perfect metal and equally perfect moulds.

DISCUSSION.

MR. J. SHAW, in opening the discussion, said he was pleased to hear confirmed that iron oxide was present in ordinary grey cast irons produced under certain furnace conditions, and also that the structure and physical properties might vary even when of the ultimate same chemical analysis due to the same cause, furnace conditions. The last fact had again been brought forward in the experiences of Shepherd as published in THE FOUNDRY TRADE JOURNAL of January 11. A few days ago he (Mr. Shaw) had submitted to him a cupola with a small open-hearth furnace in front. The metal as fast as it was melted was syphoned over into the open hearth. It was there pre-heated by two small regenerative furnaces, and doctored, if the metal needed it. Certain large claims were made for it, but a point he would like to hear Mr. Fletcher's opinion on was, would one be likely to obtain a constant structure in irons of the same analysis cast under these conditions. He (Mr. Shaw) quite agreed that faulty designed castings were a great source of trouble.

DR. DESCH, of the Sheffield University, said he had not seen the syphon arrangement mentioned by Mr. Shaw, but he had been thinking during Mr. Fletcher's lecture that it might be worth while some day to put to work a mixer such as was used in steel works practice and thereby get the large bulk of the metal equal in composition. That would undoubtedly be a great improvement on the present practice. Indeed, they might go a step

further on the lines suggested by Mr. Everitt to another Society last month. The present blast-furnaces were simple devices for extracting the metal from its ore. The only practicable method at present was to put in carbon and silicon which they did not want and then proceed to take them out in the steel works. Such a change would mean eliminating pig iron, and that was a long way off. He thought that Mr. Fletcher had perhaps over-rated the importance of gases, and that the effects shown were not a consequence of the gases, but were simply the effects produced as the process of freezing expelled the dissolved gas and the cavities were indications of what was happening in the process. That point could only be decided by making experiments with gas-free metal. They were just now installing at the University an Ajax-Northrup furnace, which would melt iron and steel in a high vacuum, and he hoped in that way to get definite information on the point. Mr. Fletcher was quite right in referring to ferrous oxide in the iron, but it was difficult to prove the matter, because they had no analytical method that they could depend on for estimating the oxide in the iron. He was convinced that ferrous oxide was present in cast iron and could affect the properties of the metal.

DR. SWINDEN said he, too, was very much interested in the subject of gases. His own experience in steel works practice was that gas had a profound influence on the soundness of the castings. One point which he was sure was quite well known to Mr. Fletcher, but to which he had not referred, was the influence of temperature on the solubility of the gases. That was worth while noting, because there was a difference of opinion on the subject. Solubility did increase with temperature and not decrease, as was suggested in certain papers published a few years ago. That was a very important point. In the case of hydrogen gas the solubility increased with the temperature at a very appreciable rate, and at the point of melting the metal absorbed a tremendous amount of hydrogen gas. The amount absorbed at melting was something like six times the volume of the iron itself, and large amounts were undoubtedly liberated during cooling, and particularly during solidification. It was not to be wondered at, therefore, that some portion of the metal had gas cavities. So far as steel was concerned, more attention would have to be given to gases other than carbon monoxide. It was quite true that they would get a reaction between dissolved FeO and carbon resulting in carbon monoxide, but from the evidence of gas analysis, there was fair evidence that other gases, particularly hydrogen, and possibly nitrogen, have an important effect. It was quite possible that hydrogen caused blow cavities and many of the other troubles to which Mr. Fletcher had referred. Another point, in electric furnace practice, for example, was that as nearly as possible one could thoroughly deoxidise, and that meant that the amount of dissolved FeO in the metal was very minute, and yet they could get a metal which would rise clean out of the moulds, showing the presence of gas. One could only think that carbon monoxide was not responsible for that particular kind of reaction. The influence of gas on the viscosity of the metal was quite well known to the steel-maker, and it was common knowledge that if the metal was not in good condition it would not run in "uphill" casting. It would in certain circumstances blow back. And again, in trough casting, if the metal was not in good condition it would not run. Whether that was due to dissolved FeO or to gases was an open question, but he thought the gases had an important bearing on that. As a steel-maker he was buoyed up with the remarks which had been made by Dr. Desch because it seemed from those that the steel-maker in the future was going to get a large share of the cast-iron business—(laughter). And if they were going to obtain the super-pig to which Dr. Desch had referred, he considered it to be a fine scheme. It was quite sound and quite practicable so far as the mixing of iron and thus getting a more uniform product was concerned. If they tried to make steel from a pure scrap basis, it was not quite a simple matter, but certainly carbon and silicon have to be removed in making steel by the open-hearth process.

MR. KAYSER said the word viscosity had been used several times, but he thought Dr. Swinden and the lecturer had not been using it in the same sense. Did Dr. Swinden mean it in the sense of being reciprocal of fluidity?

DR. SWINDEN: Yes.

MR. KAYSER said it seemed to him that there was no connection at all between viscosity and fluidity. Referring to the open top of castings, he said he did not think it was necessary to put the effects down to gases.

DR. DESCH remarked that viscosity and fluidity were defined as reciprocals of one another, and were so dealt with in Bingham's text-book on "Fluidity and Plasticity." The viscosity of a liquid was the same whether determined by flow through a channel or by a method of rotating cylinders. The sluggishness sometimes observed in metals during casting was not always due to true viscosity. It might be caused by the presence of a skin of oxide, as in the case of aluminium, or, in the case mentioned by the chairman, possibly due to the formation of a fine gas-metal emulsion.

MR. KAYSER: If you get two samples of molten metal, one fiery and the other killed, the density is the same.

DR. SWINDEN: The whole problem of the prevention of gas cavities depends largely upon the pressure, and I was hoping to hear Mr. Fletcher say whether the so-called deoxidisers dissolved gases or ejected them from the metal.

The Author's Reply.

MR. FLETCHER, replying to the discussion, said that he had seen the method mentioned by Mr. Shaw at work in Germany some years ago, but he was not impressed by its behaviour, and thought it improbable that the syphon notch, with its tendency to get quickly blocked up, could be still in use.*

The use of the mixer, however, was a much more practical solution of the problem, though he thought there was a tendency towards coarsely crystalline metal as a result of keeping large masses of molten iron at a high temperature for lengthy periods.

Mixtures of mild steel and grey iron in the ladle in definite proportions, he said, had been used with success, the steel and iron having been melted in Siemens open-hearth furnaces separately. The large castings made from this mixed metal were excellent. With reference to the removal of included gases by vacuum methods, it seemed to him, Mr. Fletcher, that the gases were held in solution or suspension in the somewhat immobile metal by surface tension influences of a much more stubborn character than could be overcome by a partial vacuum produced by pumping. The influence of FeO was, he thought, much more serious than had been generally considered.

From experiments he had made with mixtures of iron oxides and cast iron in liquid charges for puddling, the influence of the oxides on the viscosity of the fluid metal was very markedly shown.

He agreed with Mr. Kayser that there were other reasons for the increase of viscosity than that of temperature. The presence of gases with iron oxides in possibly a colloidal condition, in localised positions as in the areas of segregation, would produce viscous flow and resulting porosity on solidification of the metal.

From a long experience he had felt it necessary to keep hammering away at the gas-influence problem. Gaseous influence might not be responsible for all the troubles connected with porosity, but he was convinced that foundrymen could not give too much attention to rational methods for securing the utmost freedom from gases in the metal as poured into the mould, and from the entrance of gases to the metal from the mould.

Dr. Swinden's remarks suggested the importance of the question of highly superheated liquid cast iron. There were "after-troubles" associated with the freezing of metals which had been melted at too high a temperature in highly oxidising surroundings. These difficulties, he thought, demanded further research.

* This is being used regularly in France.—EDITOR.

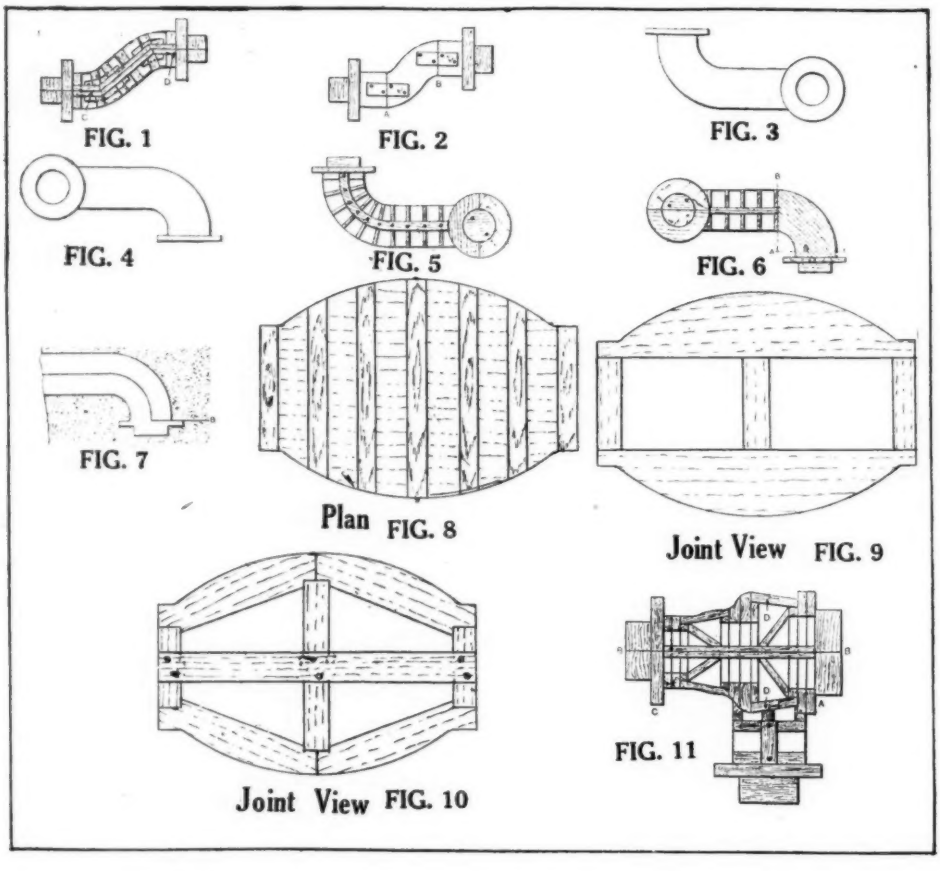
XUM

An Apprenticeship Course in Foundry Practice.—XXXV.

By Ben Shaw and James Edgar.

SKELETON PATTERNS.—II.

It is too often assumed that pipe making is a simple branch of the patternmaker's craft. It is not. There are times when the most experienced craftsman has to consider the proposition seriously, and he may be almost at a loss how to construct the work so that it may be easily moulded. Before leaving pipes, therefore, it will be worth while to consider one or two jobs that are somewhat out of the ordinary.



Double-Bend Pipes.

To make what is sometimes called a double bend, similar to Figs. 1 and 2, which show an elevation and plan respectively, the centre plates present a difficulty to the apprentice. In Fig. 2 the pattern is shown unfinished to illustrate the plate construction clearly. The most practical way of making an awkward pipe such as this is to set down a plan on a level floor or building board, and erect faces similar to those described for making patterns from templates that have been made to place. The flange centres would then be marked on these, and the bottom halves of the flanges screwed to them. The centre-plate would be broken, as shown at A and B, and strong bars, cut to the shape, screwed at the back. A ground should first be screwed to the flange and kept to the thickness of the plate below the centre. The centre-plate should now be proceeded with. It must be kept broader, and the S-shape drawn on it after it is finished. The end pieces, C and D, of the centre-plate can now be screwed to the ledge, formed by the ground on the flange, and a bracket placed at the end of it. The centre portion of the plate should now be fitted between the two parts and the bars screwed on. The S-shape can now be drawn on, and the whole plate taken away and cut to the proper shape. When the plate has been replaced, the grounds can be fixed at the short angle formed by the joining of the plate. The grounds will have to be "doctored" in to sweeten the curves. The figure will make this clear.

A double bend of a different type is that shown at Figs. 3 and 4. Each flange is parallel with the centre line of the straight pipe. Figs. 5 and 6 explain the method of construction. If such a pipe were only 3 in. or 4 in. dia. a solid pattern could be more quickly made than a skeleton. Whether the solid or skeleton method is adopted, however, the pattern will be jointed in the same way. In Fig. 7 a vertical section of the mould is shown, and the moulder would make his joint on the line AB. The chief difficulty with which he would have to contend would be in getting out the half-flange underneath the bend, and provision would have to be made for this in making the pattern.

Jointing Considerations.

It is advisable with any kind of pattern that the joint should follow the moulders' joint, but sometimes this would involve so much labour that it is not done. In the pattern under consideration it can easily be jointed to the beginning of the second bend. It would be no real help to the moulder to carry the joint straight out, however, because he is forced to joint along the centre line of the bend, and it will readily be seen that it would be a big job to joint the bend on the centre line. It will be observed that the bend, which will be in the bottom of the mould, is made solid. If the work were urgent, it would certainly be quicker to make it skeleton-style, but a solid bend delivers better from the sand. The print on the under side should be screwed to the end of the

bend, and the flange fitted over it. The inner half of the flange ought to be screwed, so that the moulder can unfasten it, and draw it out after the pattern has been withdrawn.

There are several ways in which this can be done, but pocket screws from the bend into the flange, as shown in Fig. 6, are quite good; the bend itself must, of course, be screwed to the drag half of the pattern. Although the prints at either end of the pipe are shown the same length in Figs. 5 and 6, it is not necessary to have a thick print on the under side, as it is merely a rest for the core.

Valve-Chest Bodies.

It is often profitable to make valve-chest bodies by the skeleton method. Large globe valves, for instance, lend themselves to it, if only one or two castings are required. A solid pattern for a large globe valve is very expensive, owing to the shape, which is not very easily made either by the segmental or the lagging method of construction.

In making a skeleton pattern for a large globe valve, there is a choice of several methods. The most common is perhaps that shown at Fig. 8. Joint-plates or frames are made, and cross-section pieces screwed to them 2 in. or 3 in. apart. This is a satisfactory pattern up to a point, but a great disadvantage is that there is nothing binding the section pieces on top. This objection is sometimes overcome by fitting strips of timber between the various section pieces. This ensures strength, but it is rather a slow process. There is the further objection to this method that each section piece has to be drawn separately and finished by hand, instead of being drawn from a template and shaped at the sandpapering machine.

Medium-Sized Valves.

The lagging principle is the most satisfactory for globe valves. Fig. 9 shows a medium-sized valve made in this way. Joint-plates may or may not be used. If they are used, they form building-plates for the grounds. While this form of construction makes a good pattern, and one which can be very quickly made, it is not very suitable for the largest size of valves, because of the width of the longitudinal section-pieces at the centre: at the ends the width should be at least an inch.

At Fig. 10 is shown what is undoubtedly the best method of constructing a large globe-valve pattern. This is a method which is equally suitable for a solid or skeleton pattern, and it has the great merit of being economical in timber. A stay, as shown, is usually inserted at the joint to bind the grounds together. The grounds, either one thickness or two thicknesses crossed, should be at least 2 in. thick. The section pieces can very conveniently be finished off from a template. It is much better to screw the section pieces to the grounds than to nail them, as is sometimes done. Even if a solid pattern is being made, it should not be necessary to turn it, although naturally a turned job is more accurate than one hand finished. In any case, the construction is sufficiently strong to allow of the work swinging between lathe centres. It should not be necessary to allow more than ¼ in. on the diameter for turning. As stays are used in the joint, it is not necessary to build the work on plates.

Large Stop Valves.

Fig. 11 shows a stop valve of the largest size. The main body is in section, but the branch is an outside view. The construction as shown is, like the pattern we have just been considering, equally suitable for solid or skeleton. In this case, because of the size of the job, the grounds are made in the form of segmental rings. The cover flange, A, which is usually thicker than the other flanges, and studded, is not of much greater diameter than the body of the valve, so this can be used as the first ring. Three courses of segments should be sufficient—two that are in the thickness of the flange, and one course at the back, to be used as a support for the grounds. The middle ring can likewise be in three courses. At the other end, the flange C should be made quite separate from the ring and screwed to the outside of the face-plate. Of course, these rings would have to be set off on the drawing-board and the slope of the grounds determined. The rings ought to be turned in the lathe, and the thickness of the centre plates sawn off afterwards. Templates must be made for the grounds, and the number of grounds required should be calculated. Here it may be mentioned that, as the shape will be somewhat awkward for the moulder, a better-shaped casting will probably be got if the grounds are placed close together on the rings. They will thus be open at the top only, what they gain by the two sides of contiguous grounds running gradually from the centre of the larger diameter. The mathematical man will easily calculate the number of grounds wanted; others will find by trial with dividers on the drawing-board. They need not be thicker than 1½ in. If they are very long, a rectangular recess, about 2 in. by ½ in. thick, should be cut out of the template, and a circular segment can be screwed round the ground afterwards, giving additional support and strength. When everything is ready and the rings cut, the flange A should be screwed to the plate from underneath. A stay should be brought from the flange, just under where the ground will be, to the centre frame, which will hold the flange square, and the same should be done to the other end. The middle ring can now be screwed to its place. This need not be stayed up, as the grounds will hold it quite rigid. The middle-section piece should be first fixed, and care should be taken to have it quite on the centre, so that a centre line can be drawn along the valve without inconvenience. When all the section pieces have been fixed, the edges can be finished off with the spoke-shave. The branch does not require explanation.

In some pattern shops, that end of the stop-valve pattern which is nearest the cover flange would be made as an ordinary lagged barrel. The stays, which are placed between the joint frames and the end rings are not really necessary, but they are a temporary convenience. When the pattern is completely constructed, they are not of great value.

We have included several specimens of valve work in this article because their construction resembles closely that for pipes. When a pattern-maker has to make a large pipe or valve chest in the shortest time he should not immediately decide on a skeleton pattern. It is very possible that a solid pattern may be cheaper in the long run, and it is also possible that a part-solid, part-skeleton pattern will serve the purpose best. In some shops it is the custom to make as much work as possible by the skeleton method, and the flimsiest possible patterns are made. While it is an excusable practice to make a very cheap pattern for a one-off job, yet if the cost is run up in the foundry it is inexcusable. If a shape is irregular, in most cases something approximating to a solid pattern will usually be best. It is not fair to the moulder for the patternmaker, when in a difficulty about getting a shape, to leave it to the moulder; yet it is not a rare occurrence.

Timber Considerations.

With regard to the timber used for skeleton work, it is equally important to use yellow pine, as for solid work. There is a curious idea abroad in certain quarters that the cheapest spruce is quite satisfactory for skeleton patterns. After all, the castings required must be accurate, and if this accuracy is only obtained by using an even-textured wood like yellow pine for making solid patterns, there is at least equal need for its use for skeleton work.

The apprentice will learn much about pipe patternmaking by examining old patterns, and also by watching closely the methods adopted by experienced moulders when using them.

French A.T.F. President to Visit U.S.A.—Mons. Ramas, the President of the French foundrymen's association, sails from Le Havre on the s.s. "Paris," on April 10, to take part in the American Foundrymen's Congress.

Cast Pipes and Fittings.—The total Indian imports during the period April to December, 1922, fell from 76 to 54 lakhs, those from the United Kingdom from 54 to 40, and from the United States of America from 21 to 9 lakhs. The share of "other countries" advanced from 1 to 5 lakhs.

XUM

Institution of British Foundrymen.

LANCASHIRE BRANCH.

Discussion on Mr. W. H. Sherburn's Paper on "The Evolution of the Foundrymen." *

The Chairman said he would not agree that foundrymen had lost interest in their craft. To-day work could be produced equal, if not superior, to that of the sixteenth century. The training of juniors was an important subject which had been receiving a good deal of attention of late, and quite recently a Paper* dealing with it was read by Mr. Makemson. But one difficulty in the way was that it was necessary to arouse the interest of the youths themselves. It must not be assumed that they were all anxious to learn and willing to profit by the opportunities which were offered to them. Nor did everyone in the foundry appreciate the spirit of fellowship which Mr. Sherburn recommended. In these matters the Institution had to proceed carefully: members could not be admitted without their consent.

MR. BUCHANAN said he had followed the address with much interest. Reference had been made to the secrecy which once existed. This was founded on ignorance, and it was a favourable sign that it was passing away. The war had done a good deal to sweep it away. In Birmingham the brass people were under the impression that they knew all about brass, but the Government had to come to their help to get them out of their difficulties, and grants were made to the University and technical schools for that purpose.

The question of personal contact between employer and employee was coming largely to their notice, and rightly so. He did not know any other solution for closing the chasm that had existed so long than along the lines indicated by Mr. Sherburn.

MR. J. HOGG said he served his time under his father, a conscientious man who used to take active interest in every man in the foundry. He would have made an ideal foreman, and from him he (the speaker) picked up many ideas and hints which were of great service in his own experience. It sometimes happened that a man, usually a good practical workman, was for some reason not in the right mood for his work. A little sympathy might see him through his trouble. He need not go off work altogether; he could be put on to another job for a time.

Mr. Makemson's Paper referred to was splendid, although he did not agree with all that it contained. For instance, he did not accept the suggestion that a boy ought not to start work in the foundry before the age of 16. It was much better, he thought, that he should begin to acquire practical experience in the works at 14, and for two years combine that with the education given in the school classes. It would be an excellent thing for the trade if the rank and file were properly trained.

MR. COLEMAN said the training of youths was a psychological matter; the mind had to be considered. Those in charge of a boy should take an interest in him, and show it not only by instructing him how to do his job but also in relation to other things. There were things outside the foundry which were of importance. Personally if he could do anything to interest a boy in drawing, music, or art he should do so. Training given when he was young determined the character of the man. As foundrymen they ought to aim at the highest and the best, not for themselves alone but for those around them also.

THE CHAIRMAN said he was impressed with a sense of the responsibility which devolved upon an organisation such as the I.B.F. They were striving to recover what had been lost, to attain the things which were necessary, and there were many difficulties in the way. The war had brought about a good deal of disruption and upset, and to remedy its effects much would have to be done. But he did not think they were quite so badly off as some people would have them believe. Obviously it was impossible for the managing director of a large firm employing 2,000 or 3,000 people to get into personal touch with all of them, but he was sure that they had the interests of their workpeople at heart, and the members of the Institution would be fulfilling the wishes of the management in doing all they could for the benefit of those under them.

MR. A. L. KEY, in proposing a vote of thanks to Mr. Sherburn, said he agreed with one of the speakers that under present-day conditions the training of youths was as much a psychological question as one of practical knowledge.

In seconding the vote of thanks, Mr. S. G. Smith emphasised the necessity of getting lads to take an interest in their craft.

The Author's Reply.

MR. SHERBURN, in replying, said he was glad to find members in agreement on the points of the Paper. He did not suggest that the members of the Institution took less interest in their craft than was formerly the case, but the criticism was a common one and was just if applied generally. That difficulty had to be overcome if the industry was to reach a higher level. At the same time, if they recalled what was the state of things when the Institution was founded 20 years ago, the contrast with the present should fill them with encouragement and renew the hope that the next 20 years would see a similar stepping forward.

What Constitutes Craftsmanship?

In connection with training in craftsmanship three things should be kept in mind. Was it skill in bedding and jointing loose patterns so many times a day when one could get them on a plate and have no bedding at all? He remembered a time when patterns with intricate partings or joints were bedded day after day, so many a day, for years. Presumably a man who did that work well would consider himself a craftsman. He did not altogether agree with that. It seemed to him that the natural evolution of craftsmanship was that as processes were simplified they were put under mechanism which freed the mind of man for further research into the more elaborate problems which presented themselves. None could say they had reached the end and were always making perfect castings; there still were more than enough wasters and many were sent out. The things that they had learned to do became mechanical things; craftsmanship aimed at the accomplishment of the things that they had not yet done perfectly, and the field for it was as wide now as it had ever been. So they needed to have an open vision.

Training for Control.

Many men were not quite sure what were the essentials for control in the foundry, meaning thereby not the supervision of a managing director, but the immediate control of the men. For a position of responsibility more was needed than a thorough knowledge of the craft, there must be some general business knowledge, and, above all, a *knowledge of men*, and the faculty of getting on with them and of drawing the best out of them. The man who was a good craftsman and nothing more would remain a subordinate, he would seldom rise.

The Choosing of Boys.

During the last year at school the parents and the teacher should try to ascertain a boy's capacity and bent of mind, so that a suitable opening might be found for him. He had been amazed by the ignorance of parents in that respect. When introduced to the foundry, the boy should be given an elementary text book, which explained and elucidated the elements of the craft—just a little thing which he could put in his pocket and refer to whenever he desired. At the end of a year he should be examined on the matter contained in that book; if the result was satisfactory an intermediate book should be given to him. Later there would be a third and more advanced book. Other books of a more advanced character he could procure from the works library or from the superintendent of his department. Text books

* This Paper appeared in our issues of Feb. 15 and March 1.
† See FOUNDRY TRADE JOURNAL, Jan. 25 issue, 1923.

on these lines should be prepared for the moulder, the pattern-maker, and the fitter, and it would be found that the aspiring youth in either department would want to study all the text books of the three departments. The guidance of his superiors would show him the most useful way to spend his spare time. If such small manuals were prepared in simple language such as a craftsman would use to a boy in whom he felt an interest, they would be stepping stones or incentives to the study of the standard technical literature of his craft, by the human touch which is so valuable but which the latter often overlook.

DISCUSSION ON Mr. PETER J. HILL'S PAPER ON "A PRACTICAL COST SYSTEM FOR THE SMALL OR MEDIUM-SIZED FOUNDRY."*

In opening the discussion the Chairman (Mr. J. Haigh) said at the present time costing was perhaps more important than any other subject which occupied the attention of foundrymen. He knew a case where general engineering castings were being sent into a district from outside at 8s. per cwt. It was time that information as to the proper methods of costing and ascertaining the prices at which castings could be sold reasonably was not only circulated but assimilated by the people concerned. Mr. Hill's address would, therefore, be of much benefit to the members, and assist those who were in difficulties with a costing system.

An important point might have been elucidated more. Suppose a shop where the work was done by hand a certain amount was put on for the overhead costs. If the work was put on to machines, the labour cost in proportion to output was decreased, and the percentage put on for indirect or overhead charges must be increased. It was a difficult matter to allocate accurately the labour on machine-moulding jobs, and apprentice labour was also troublesome.

Mr. Hill was quite right to base his calculations upon the castings produced and not upon the weight melted. The price at which they were made was the true basis, not the cost of the metal.

The main point he wished to emphasise was that the management should use these figures for the purpose of reducing the costs or increasing the efficiency; otherwise the time spent in preparing them and presenting them was wasted.

Costing for Hand and Machine Moulding.

Mr. Hill agreed that the distinction between hand moulding and machine moulding in the allocation of costs was not an easy matter to deal with until one reached the rock-bottom elements of costing. In a foundry worked solely by hand, an overhead rate of so much per hour or so much per person could be arrived at, but those figures would be useless, when they considered machine moulding. The direct labour cost was, of course, very much lower, but a great deal of money was expended in other directions. The installation of machines involved capital outlay, and interest had to be paid to the people who had invested their money in the purchase of those machines, provision had also to be made for the upkeep and maintenance of the machines, and for the cost of the labour employed upon them. Those items should be treated separately. To put it in another way, installing machines reduced the proportionate cost of labour in comparison with the capital invested, which constituted a permanent charge on the factory, and did not have any direct relation to the quantity of goods produced. In a mixed shop, where both machine moulding and hand moulding were practised, some difference must be made in the overhead charges applied to each. If spread over the whole upon an average basis, the hand-made castings would bear more than their fair proportion, and the selling price worked out would be higher than was justified.

Plant Replacements.

Replacements of plant and maintenance of plant were included in the indirect factory expenses as separate items, the former under "Materials," the latter under "Labour." Depreciation was a third item added to the total cost in arriving at the selling price. That did not mean there was any duplication. Depreciation was something separate from the repairs and upkeep of a plant. In the two latter items was included the expenditure required to maintain it in a fit condition to carry on its work, but they did not provide a fund to replace it, or to return the capital invested in it, when it became obsolete.

Departmental costing or the costing of individual castings could be done without any great effort. To the cost of the iron and the direct labour was added a variable figure for the indirect expenses and other charges which were attributable to the department or the individual casting. Establishment and general charges, of course, did not vary according to output; therefore if that went down the proportion attributable to any particular department or casting would increase.

The underlying principle was to show what a job was really costing and enable a price to be fixed which would prevent losses. The system he had described was in operation to-day, and had been proved by financial results.

Role of Works Accountant.

Mr. Jolley said he considered the works accountant was in the position of a doctor whose duty was to prevent disease rather than wait to cure it. The works accountant should do his work before prices for castings were sent out. He observed that in Mr. Hill's figures factory expenses were put at a certain percentage on the assumption of a certain output. If that output were doubled presumably the factory expenses would come down. Did Mr. Hill make any allowance for that? Of, if the output diminished by one-half, how did Mr. Hill treat it then? He thought the overhead charges should go to the cupola account and not to the grand total.

Labour appeared in three items: (1) as cupola labour in cost of iron at the cupola spout; (2) as direct labour (moulding and coremaking), and (3) the indirect factory expenses. Now take the case of a general shop where a large number of very small castings are produced and also in another part of the shop heavy work. On some jobs two or three moulders were employed to one labourer. Was allowance made for the difference in the conditions by adding direct labour to the job, or was it carried into the indirect factory expenses? If booked as direct labour some jobs would carry a double burden.

Mr. Hill said the works accountant should not be placed in the position of being called in after the mischief had been done, to make a *post mortem* examination; he should watch the progress of things and suggest how they could be improved. On the question of the relation of factory expenses to output, there were some charges which remained stationary whether the output rose or fell. If the calculations were worked out on an average output it would be quite safe to proceed upon that basis if the output increased, but if it diminished the factory expenses were not sufficiently covered. It might be thought better to lose a bit in order to get business and, at all events, it was better to face the facts with one's eyes open.

The indirect labour on certain jobs was assistance to the moulders, but could not be correctly included in the accounts as "moulding"; it should be treated separately and allocated to the castings according to weight. It would not do to take it as an average figure, because that would mean that a casting done by moulders alone, without extra assistance, would bear part of the expense incurred on other castings. It was necessary to grade the castings.

Mr. R. A. Miles remarked that this had not been a paper of the dry-as-dust type. It had been a very interesting paper, and many points were raised which offered food for thought in future, if they had not been cleared up satisfactorily.

Mr. Pell expressed a hope that the paper would appear fully in The Foundry Trade Journal, so that the members might be able to study it at leisure.

Mr. Horrocks said the main object of costing was to arrive at the true price so as to ensure that there should be no loss. The system described had been proved by the ledgers at the year's end. It seemed to him somewhat strange

* This Paper appeared in our issues of March 8 and 15, 1923.

that the replacement of castings should go into the indirect labour account. He thought the expense of dressing and fettling should also be treated as a direct charge. It was in dressing that it was ascertained whether the casting was good or bad. It was a known quantity and easily apportioned to the individual castings. He proposed a vote of thanks to Mr. Hill for the lecture.

In seconding the vote of thanks, MR. H. SHERBURN said the position of the foundryman was more difficult to-day than it was a few years ago. At one time he was called upon to consider questions of silicon and sulphur and the like; to-day he had put before him columns of figures and charts, and was expected to carry on his work on the basis of those things. If these were used against him unreasonably, it was quite understandable that a feeling of dislike and opposition to them would be fostered. If they were submitted to the foundryman for his guidance, with the object of improving upon present practice, well and good. Mr. Hill had dealt with a lot of figures and items, some of which individually were of secondary importance. The main point was that fundamentally the system was right.

The CHAIRMAN said he had never known a more simple and comprehensive explanation of this subject than Mr. Hill had given. He agreed with Mr. Sherburn, the foundryman would appreciate the advantages of a proper costing system and try to carry it out if he was approached in the right spirit.

The vote of thanks was carried unanimously.

In replying, MR. HILL said if standardised methods were adopted in this country competition would not be so keen; it would be upon sensible lines. With regard to putting replacement of castings in the indirect labour, obviously the item could not be included twice; the article was only sold once. Some special provision must be made for the case, and it appeared to him that when the casting was made a second time it was really a replacement cost and not a first cost. It was a charge which ought to be borne by the foundry. He believed all foundries had their wasters. If desired they could be put to a suspense account and charged at so much per month or so much per ton.

MR. HORROCKS: The point is whether that is the best way of dealing with defective castings, to put it into direct labour. It can be dealt with by reducing the weight of the good castings and putting it with the rest of the wasters.

MR. HILL: The point is that you get the waster first, and the second one is a good casting.

MR. HORROCKS: Yes.

MR. HILL said the material used in making the waster went back into the cupola. There was a reduction in the iron cost. He indicated on the chart where the labour cost would be taken, and pointed out that provision for the waster was made the first time. With regard to dressing it was optional whether that should be a direct or indirect charge, but in a small foundry there might be some difficulty in treating it as a direct charge. He agreed with Mr. Sherburn that costing was a matter for co-operation, and that the management should use the figures for the benefit of the work and not to penalise the foundryman.

BURNLEY SECTION.

Plaster Pattern Making Demonstration.

At a meeting of the Burnley section of the Lancashire Branch, held on February 7, at the Technical College, Burnley, Mr. J. Hogg presiding, a demonstration of the making of plaster patterns was given by Mr. R. Christie, of Padiham. He prefaced it by stating that most of his experience of plaster patterns had been in connection with very light work, such as grates, ranges, mantel-pieces, and so forth. He did not think it was adopted to any large extent in heavy work, but in patterns of a lighter character there were some things that could be done in plaster which it was practically impossible to make in wood. If it were not for plaster he did not know how they would be done at all.

The subject of the demonstration was the leg of a bedroom mantel. The first part run on the board was a block which gave the shape of the back of the pattern. Two pieces of wood nailed on the board prevented the plaster from moving; without them the job might shift, and the work would then have to be done over again. To prevent the second thickness sticking this block was varnished with shellac, a process which put a skin on it. It was afterwards coated with vaseline. A circular piece was also demonstrated.

Making Bends and Elbows.

The CHAIRMAN described how the method was adopted in the production of bends, elbows, and T pipes. At first it was decided to make them in wood, and have a core-box in two parts. When they found out how long that would take they looked out for a quicker, cheaper, and better method. So they called in Mr. Christie, who made a complete set of plaster patterns for making the outsides of the pipe patterns and also the core-boxes for the insides. Those were a complete success and were still being used, and if anything of a similar nature had to be done he should have no hesitation in using plaster patterns. For anything elliptical or circular, or with a bend such as an elbow pipe or a straight piece with a branch attached to it, the method was very satisfactory; he had never seen anything done in a better manner than those pipe patterns.

He thought it was only fair that the customer should pay more for such work than for ordinary castings from a wood or metal pattern. The moulder required more skill, he used more care, the job took longer. At the same time it was a better one, and any amount of ornamental work could be introduced.

Replying to a question Mr. Christie said trouble sometimes arose from contraction of the plaster, but usually he found the plaster, for the first two or three days, swelled. After weeks of time had elapsed it did contract.

MR. PELL, who had examined specimens of plaster patterns handed round to the members, remarked that some other ingredient than plaster appeared to have been used. Could Mr. Christie say what it was? It was a very old one.

MR. CHRISTIE said the pattern only contained plaster. He had, however, seen men who ran short of plaster substitute cement. Plaster was used when it did not pay to make a pattern plate. If the job was not repeated the plaster could be broken up.

Choice of Plaster.

MR. CHRISTIE said he preferred the superfine modelling plaster, which was very white and very fine. It was stronger and gave a much smoother surface than the coarser material.

MR. PELL: Some is very coarse.

MR. CHRISTIE said sand was mixed with some plaster he bought. He had used it but did not get as good a surface, nor, he thought, as strong a job, as with the fine plaster.

MR. PELL said when Mr. Heggie gave a paper on this subject before the Lancashire Branch at Manchester several samples of plaster were shown, but he did not think anyone asked which was the most suitable grade to use. In his own plaster work they did not require any special superfine material. They used the plaster as long as it would stand.

MR. MCLAREN remarked that there was a great deal in the mixing of plaster. One man would mix it and get a crumbly pattern; another man, using the same quality of stuff, would get it almost like pottery.

The CHAIRMAN said when a paper on this subject was read in Manchester some two or three years ago it was surprising the number of questions which were asked about mixing the plaster. There were foremen moulders, and pattern makers, too, who had never seen it done. They were asking what consistency the plaster should be, the sort of question which showed that they were not in the habit of using plaster.

MR. CHRISTIE said if a job was going to be as good and true a job in wood, as in plaster, and cheaper, they would use wood; but plaster was sometimes cheaper, and it produced a very good job equal in thickness throughout. It was cheaper than wood for much circular work, where to do it in wood would require a considerable amount of building up and much timbering. The saving from the use of plaster was very great there.

Then many jobs, say a tenth of an inch to one-eighth thick, would be very fragile if made in wood, more fragile even than plaster.

MR. PELL pointed out that Mr. Christie had completed two jobs in an hour and a quarter. Could any pattern maker have done them in that time if he had used any other material? It was impossible to do them as rapidly and also as well. If a wooden pattern of similar dimensions were given to a moulder and put in the sand it would come back in bits. The demonstration had proved that on certain classes of work, at all events, plaster produced a more suitable job, and a cheaper one, than wood.

A vote of thanks to Mr. Christie was passed unanimously on the motion of Mr. Place.

Determination of Manganese in Pig-Iron.*

Sodium Bismuthate Method.

One gramme of the sample is transferred to a 250-c.c. Erlenmeyer flask and dissolved in 50 c.c. of nitric acid (sp. gr. 1.13). The solution is boiled to expel the nitrous oxide fumes, when it is cooled and filtered, the residue being washed with nitric acid (3:100). The filtrate is heated nearly to boiling, and the organic matter is oxidised by the addition of successive small quantities of sodium bismuthate until the pink colour of permanganic acid persists or the brown oxide of manganese precipitates upon boiling. A 3 per cent. solution of H_2O_2 or a 5 per cent. solution of ammonium bisulphite is now added, a few drops at a time, until the manganese dioxide is dissolved. The excess of the reducing reagent is expelled by continued boiling. Ammonium persulphate may be substituted for bismuthate for oxidising the organic matter; in this case, the excess ammonium persulphate is destroyed by boiling.

The solution is cooled rapidly to a temperature of about 15 deg. C. and diluted to a volume of 50 c.c. An excess of sodium bismuthate, from 0.5 to 1 gramme, is added, whereupon the mixture is vigorously agitated. The solution is decanted through an asbestos filter and the flask and filter are washed with HNO_3 (3:100) until the washings are colourless. The HNO_3 is freed from nitrous fumes immediately before dilution by bubbling air through it for 20 minutes or more. The solution is then transferred to a 250-c.c. beaker and 3 c.c. of phosphoric acid (sp. gr. 1.71) are added. Standard thirtieth normal ferrous ammonium sulphate solution is now added from a burette until an excess of approximately 10 c.c. is obtained. The total volume used is noted. The excess ferrous ammonium sulphate is then determined by titration with standard thirtieth normal potassium permanganate solution. The difference between the volume of permanganate solution required and the volume of permanganate solution which is equivalent to the total volume of ferrous ammonium sulphate solution added is multiplied by the weight of manganese in 1 c.c. of the standard permanganate solution. The result thus obtained is multiplied by 100 to find the percentage of manganese.

This method is susceptible of giving accurate results, and is therefore recommended in cases where especial exactness is required. Care should be exercised to exclude nitrous oxide fumes, organic matter and chlorides from the solution to be titrated, for traces of these substances therein vitiate the results.

Solutions Required.

Sodium Oxalate Solution.

Sodium oxalate ...	1.000	gramme
Water	1,000	c.c.

Thirtieth Normal Potassium Permanganate Solution.

Potassium permanganate	1.06	grammes
Water	1,000	c.c.

The potassium salt is dissolved in boiling water and the solution is allowed to stand for 24 hours. It is then filtered through an asbestos filter and standardised as follows: 100 c.c. of the sodium oxalate solution are transferred to a 400 c.c. beaker and 20 c.c. of H_2SO_4 (1:1) are added. The contents of the beaker are heated to 80 deg. C., whereupon the standard permanganate is added, slowly at first and then rapidly, until a permanent pink tint is obtained. The weight of manganese equivalent to 1 cub. cm. of the standard permanganate solution is found by the following calculation:—

$$\frac{0.0163958}{\text{(Vol. in c.c. of } K_2Mn_2O8 \text{ solution required to oxidise 100 c.c. of the sodium oxalate solution.)}}$$

The figure 0.0163958 is the weight of manganese in the form of permanganate, expressed as the fraction of a gramme, which is equivalent to 100 c.c. (0.1 gramme sodium oxalate) of sodium oxalate solution.

Thirtieth Normal Ferrous Ammonium Sulphate Solution.

Ferrous ammonium sulphate	13.1	grammes
Sulphuric acid (1:1) ...	100	c.c.
Water to make ...	1,000	c.c.

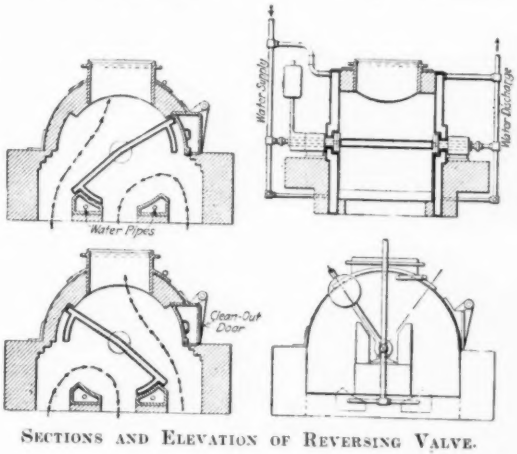
Nitric Acid (Sp. Gr. 1.13).

Concentrated nitric acid	240	c.c.
Water	760	c.c.

* A method used and published by the United States Steel Corporation

Reversing Valve for Regenerative Furnaces.

The W. R. Miller Company, Pittsburgh, U.S.A., has placed on the market a reversing valve of the construction shown in our illustration, for regenerative furnaces. The flapper and the wall plates are of welded steel, water filled. The bottom seal, resting on brick walls, can either be a casting for air circulation or of welded steel, water filled, the latter preferred. The reversing lever, for either hand or power operation, can have a small motor attached for large valves, while the smaller valves can be actuated by any operating rigging. The lever rests against wood or other material acting as a cushion. Access to the interior of the valve, when replacement is required, is easy. The Company claim for this new design of valve that it is simple of construction, requires only a small amount of space to install, and is of low installation cost. The path of gases is shown by the line of arrows.



SECTIONS AND ELEVATION OF REVERSING VALVE.

Rolling Stock for Finnish Railways.—The Finnish Railway Board has decided to submit to the Government a proposal for increasing the rolling stock of the Finnish railways by 35 engines, 1,000 goods wagons, and 50 passenger carriages per annum during the ensuing three years. The sum required for the carrying out of this programme is estimated at about 85 million Finnish marks (say £500,000 at current exchange).

Trade Talk.

THE ROCK FOUNDRY, BLACKWOOD, MON., is about to be closed.

EEKHOUT & COMPANY, LIMITED, have removed their Glasgow office to 94, Hope Street.

THE TURBINE FURNACE COMPANY, LIMITED, during the last two months, have taken 23 orders for their furnaces.

THE ADDRESS OF H.M. Senior Trade Commissioner in Canada and Newfoundland is now 285, Beaver Hall Hill, Montreal.

SIX VESSELS WERE LAUNCHED from the Tyne shipyards in February of 18,621 tons, compared with six of 28,890 tons in February last year.

MR. E. ADAMSON, of Sheffield, presented a paper to the Manchester Association of Engineers at the Memorial Hall, Albert Square, Manchester, on "Carbon in Cast Iron."

BOLCKOW, VAUGHAN & COMPANY, LIMITED, have restarted a seventh blast furnace on Cleveland iron in North Yorkshire, and the second blast furnace has been started at Normanby.

MELDRUMS, LIMITED, Timperley, nr. Manchester, in the first four or five weeks of the year took 18 orders for forced-draught furnaces and nine orders for steel-cased destructors. Many of these are repeat orders.

THE DOMINION ALLOY STEEL CORPORATION, LIMITED, has been granted Federal incorporation with an authorised capital of $15,000,000. Mr. J. A. Baird, 149, Front Street, Sarnia, Ontario, is associated with the company.

LICENCES UNDER THE Non-Ferrous Metal Industry Act, 1918, have been granted to D. E. Morris, trading as D. E. Morris & Company, 15, Seething Lane, London, E.C.3; H. Sibille & Company, Limited, 70, Victoria Street, London, S.W.1; and J. L. Smith & Company, Imperial Buildings, Cardiff.

THE ASCERTAINMENT under the sliding scale in operation in Cumberland and North Lancashire shows that the selling price of West Coast hematite Bessemer mixed numbers for January and February was £4 15s. 7.01d. per ton, an increase of 3s. 4d. per ton compared with the ascertainment for December, 1922.

THE NORTH EASTERN STEEL COMPANY, LIMITED, of Middlesbrough, have recently placed an order with Simon-Carves, Limited, Manchester, for 60 regenerative ovens to be built at the Acklam Ironworks. This will complete an installation of 120 ovens. The first 60 have been in actual operation for the past three years.

THE WORK OF THE DISMANTLING and breaking up of old warships in Cork harbour, which had been entrusted to T. W. Ward, Limited, of Sheffield, is now lost to Ireland, for arrangements have just been made for the removal from Cork harbour waters of the three obsolete warships, the "Cumberland," the "Edgar," and the "Mersey," for breaking up in Morecambe Bay.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, Newcastle, have secured an order from Sweden for a passenger steamer of 17,000 gross tonnage, with a speed of 17 knots. The Furness Shipbuilding Company, Stockton, have booked orders for an 8,000 tons motor vessel, two 4,000-ton steamers, and two smaller vessels, all for London owners, and also an order for constructional steel for colonial railways. Vickers, Limited, have obtained a contract from the Donaldson Line, Limited, for building at their works at Barrow, two large cargo and cattle liners, to operate between Liverpool, Glasgow, and Canadian ports.

THE FORTY-SEVENTH ANNUAL REPORT of the Midland Iron and Steel Wages Board shows that there are 86 firms affiliated. The last report showed the rate for puddling from December 3, 1921, to February 4, 1922, at 13s. 6d. per ton plus 110 per cent., and from that period the following settlements have been made: February 4, 1922, to April 1, 1922, 13s. 6d. per ton plus 90 per cent.; April 1, 1922, to June 3, 1922, 13s. 6d. per ton plus 62½ per cent.; June 3, 1922, to August 5, 1922, 13s. 6d. per ton plus 50 per cent.; August 5, 1922, to October 7, 1922, 13s. 6d. plus 45 per cent.; October 7, 1922, to December 2, 1922, 13s. 6d. per ton plus 40 per cent.; December 2, 1922, to February 3, 1923, 13s. 6d. per ton plus 42½ per cent. Mr. W. R. Lysaght has again been appointed the representative of the Employers' Section of the Sheet Trade Committee on the Standing Committee of the Midland Iron and Steel Wages Board for the year 1923, with power to Mr. D. C. Lysaght to act in his absence, and Mr. J. Fisher has again been appointed representative of the Workmen's Section of the Sheet Trade Committee. The receipts from employers totalled £2,379, an increase of £512, and from the operatives £2,366, an increase of £498. The total expenditure for the year has been £5,786.

Company News.

Hipper Foundry Company, Limited.—Capital £2,000. Directors: R. Holland and A. B. Short, Manor Farm, Chesterfield.

Charles Baker & Company of Tonbridge, Limited, 150, High Street, Tonbridge, Kent.—Capital £12,000 in £1 shares. Engineers.

Charles H. Smith, Limited, 26, Wapping, Liverpool.—Capital £1,200 in £1 shares. Engineers. Directors: T. R. Robertson and N. H. Roberts.

E. J. Smith & Company (Metals), Limited, Tyseley Metal Works, Birmingham.—Capital £500,000. Permanent directors: E. J. Smith and G. W. Booth.

Frederick Fleming & Company, Limited, Dean Street, West Vale, near Halifax.—Capital £3,000 in £1 shares. Brass founders. Directors: Mr. and Mrs. H. F. Wheater.

Douglas Lawson & Company, Limited, Gelderd Road, Birstall, near Leeds. Capital £40,000 in £1 shares. Engineers. Directors: C. Douglas (chairman) and A. M. Lawson (both permanent).

Albert Thorpe, Limited, Sainsbury's Buildings, Campo Lane, Sheffield.—Capital £3,000 in £1 shares (1,000 8 per cent. preference and 2,000 ordinary), Engineers, etc. Directors: A. Thorpe and J. Boreham.

Bonniwell & Watson, Limited, 26, New Exchange Buildings, Middlesbrough.—Capital £5,000 in £1 shares. Iron merchants. Directors: R. G. Bonniwell, Mrs. L. Watson, J. W. Armstrong and C. A. Clayton.

British Aluminium Company, Limited.—Profit, £83,803; depreciation, £30,000; reserve, £10,000, with £30,000 reserve against investments not required; final dividend, 5 per cent. per annum on ordinary, making 5 per cent. for year; forward, £15,777.

Browett, Lindley & Company, Limited.—Net profit, £7,100; depreciation, £5,036; brought forward, £10,736; dividend, 8 per cent., less tax, on ordinary, 4 per cent. paid September 30; carry forward, £11,836; preference dividend to be increased from 6 per cent. to 7½ per cent.

Stewarts & Lloyds, Limited.—Depreciation, £70,000; dividends for half-year, 6 per cent. per annum on preference; 10 per cent. per annum on preferred ordinary; 2s. and bonus of 6d. per share on deferred; reserve, £100,000; employes' benefit reserve, £10,000; carry forward, £150,000.

Friend, Wintle & Company, Limited.—Capital £2,000 in £1 shares, to adopt an agreement with H. Wintle and to acquire the business carried on as Friend, Wintle & Company. Electricians, mechanical engineers, etc. Permanent managing director: H. Wintle. Solicitor: R. W. Nicholas, 31, Queen Street, Cardiff.

Stainless Iron & Alloys Company, Limited.—Capital £100,000 in £1 shares, to acquire certain patents relating to the production and manufacture of non-rusting iron and steel, etc, to adopt an agreement with Hamilton & Evans (Wigan), Limited, De Jersey & Company, Limited, W. B. Hamilton and T. A. Evans. Solicitors: G. M. Peck, 27, Library Street, Wigan.

Gazette.

THE STAR ELECTRICAL ACCESSORIES, LIMITED, are being wound up voluntarily, with Mr. H. J. Gittings, 55, Temple Row, Birmingham, as liquidator.

THE PARTNERSHIP heretofore subsisting between Messrs. F. Morris and F. Richardson, Shawlcross Iron Foundry, Horwich, near Whaley Bridge, under the style of the Shawlcross Iron Foundry, has been dissolved. Mr. Frederick Morris continues.

MESSRS. H. J. ALEXANDER, J. H. SMITH, JUN., A. F. KINSEY, AND F. B. MARTIN, trading under the style of the British Machining and Drop Forging Company, at Roway Lane, Brades Village, Oldbury, have dissolved partnership. Messrs. H. J. Alexander and J. H. Smith, Jun., will continue.

AT THE EXPIRATION of three months, the names of the undermentioned companies will be struck off the Register of Joint Stock Companies, and the companies will be dissolved: Anti-Rust and Metal Deposition Company, Limited; Brasscasters, Limited; Electric Furnaces and Smelters, Limited; Heskett Steel Castings (British), Limited; Howard Smith Engineering Company, Limited; Maggi Foundry and Smelting Company, Limited; Marine Metal Company, Limited; Metallurgists, Limited; Metro Manufacturing and Engineering Company, Limited; Patrick Engineering Company, Limited; Pullan Engineering Company, Limited; Railway Supply, Construction and Engineering Company, Limited; Richard Rostron (Engineers), Limited; Saxon Engineering Company, Limited; Swindon Engineering Works, Limited; Universal Engineering Company, Limited; and the Wellington Steel Works Company, Limited.

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Telephone: 4639 VICTORIA

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Telegraphic Address: "STAVIRON, MANCHESTER."
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Pyridene
Sulphate of Copper,
Sulphate of Iron,
Red Oxide of Iron,
Bleaching Powder,
Caustic Soda,
Accumulator Acid,
Creosote Oil,
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"STAVEHO" For Making Cement Work Waterproof.

PLEASE WRITE FOR PRICES.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The market for Cleveland iron continues in much the same position as previously reported, the present output from Tees-side furnaces being completely inadequate to cope with the requirements of home consumers, while also satisfying the demand for export supplies. Inquiries on Continental account meantime are in augmented volume, the demoralisation of French and Belgian furnace interests, owing to the failure of fuel supplies, being responsible for the bulk of the offers coming forward, which, in this district at all events, it is practically impossible to meet. There is now virtually no iron to be had for early deliveries, makers being fully sold over the current quarter, while buyers for April will be very fortunate if obtaining even moderate tonnages before June. Another furnace on Cleveland iron has, however, been relighted, while other plants are reported in readiness to be put in blast, if and when assured coke supplies are forthcoming. In the meantime Cleveland pig quotations have taken a further upward turn, No. 3 G.M.B. having been advanced last week by another 2s. 6d., or 127s. 6d. per ton, while No. 1 stands at 132s. 6d., with a strong demand for this quality from the Continent. Makers who have any No. 4 foundry to offer are quoting 125s. for it, and No. 4 forge, of which there is none available, is nominally 117s. 6d. per ton. The addition of the above-mentioned furnace on Cleveland iron and one on hematite brings the total number of furnaces now in blast on the North-East Coast to 45, of which 17 are on hematite, 15 on basic and special kinds of iron, and 13 on Cleveland iron.

In common with ordinary iron at Middlesbrough, there is now a pronounced scarcity of hematite for any early delivery, May being in most cases the earliest date obtainable. Meanwhile the demand all round continues to increase, and recent additions to the output seem to have made no impression on the position. France, Germany, Czecho-Slovakia, and Italy are all in the market. Compared with previous quotations, the price of East Coast mixed numbers is 5s. higher at 125s., and No. 1 is at a premium of 1s. to 1s. 6d. per ton. On the North-West Coast hematite furnace interests have again advanced prices, Bessemer mixed numbers being quoted 135s. to 137s. 6d. per ton delivered Sheffield and Glasgow, and round 140s. for export.

MANCHESTER.—A somewhat peculiar position has developed in connection with the local market for foundry pig-iron, many Lancashire consumers of this quality pig having bought well forward from Midland furnaces at moderate prices early in the year, ranging from 88s. 6d. to 92s. 6d. per ton, in some cases for deliveries extending over the first quarter, and even later. They are now asked to pay 115s. per ton, delivered, for the same class of iron, furnace owners maintaining that the rise in coke and the costs of production will justify this big increase. Consequently, Manchester ironfounders are now holding back, and to a large extent refusing to buy pig-iron at current prices, but it would be presumptuous to say that they are wrong, although if they allow stocks to become absolutely exhausted they may be taking a certain risk. There is very little iron offering here for forward delivery, because, although the prices are high, blast-furnace owners are nervous as to what may happen if the shipping demand for coke should increase still further. Both Scotch and hematite iron are again dearer in this market, and some sellers of Scotch No. 3 are now talking of 140s., delivered in Manchester, although it is probably possible to buy at less than this.

THE MIDLANDS.—Reports from the chief centres of the smelting industry within this area confirm previous conditions as still maintained, current demands readily absorbing furnace outputs, and would unquestionably consume even more were supplies of pig available. The limited production of iron, due to irregular coke supplies, is greatly hampering business, with the result that there are still many furnaces standing idle, as they have been since the coal strike of 1921. Ironmasters would, of course, be only too glad to restart these idle plants, but are restrained by lack of the essential fuel, a large proportion of which is being exported to feed foreign furnaces. Consequently there is little, if any, iron available for prompt delivery. Of course, if the buyer cares to pay the requisite price, there is always iron to be obtained, no matter how great the stringency may seem to be, but the majority of the smelters who look to this district for a market report that they have no iron to offer for early delivery, and some of them declare that they cannot quote for any earlier delivery than June. Naturally, in view of the present outlook, quotations for forward delivery are very high, and each passing week sees them further advanced, and, of course, very firm.

SCOTLAND.—An outstanding feature of pig-iron market movements at the moment is an insistent demand from the Continent, sales of several thousands of tons having been booked at Glasgow during the current month. Buying is almost entirely confined to foundry pig, most of which is bought for Germany, but France and Holland are also taking a share. Prices are higher again by 2s. 6d. per ton at 120s. f.o.t. furnaces and 125s. f.a.s. Glasgow for Dalzell, Summerlee, Glengarnock, Gartsherrie, and other No. 3 foundry. The present price is higher by 25s. than at January 1, and the home consumer considers the advance as artificial, and is not inclined to follow it. There is no increase to report in production, but one firm of smelters, who produce their own fuel, are contemplating the relighting of four furnaces, and these may be operating shortly.

Finished Iron.

The steady improvement in most descriptions of finished material already recorded is so far fully maintained, and business both for home and export is distinctly better, with an appreciable decrease of unemployment in these branches. The bar-mills are well employed, with an active demand for best crown qualities of iron, the outlook for the near future stimulating buyers to covering for requirements by forward purchases to a greater extent than has been the practice for some time past. Values also have taken an upward turn, marked bars having been advanced last week, but in view of the demand for best iron and the concurrent advance in raw materials this movement was hardly unexpected. Crown iron has now more than recovered the lost ground as compared with marked. Some of the best known and most reliable makes now command £12 10s. for Birmingham delivery, which represents a substantial improvement on the price ruling at the beginning of the year. These makers are now able to keep their mills fully occupied, apart from delays which may arise from inadequate deliveries of pig-iron, and when the pigs are bought right there is an adequate profit on the business done. In other cases, however, makers are not any better off than they were. Quotations for other qualities taper down until the price of nut and bolt iron is £11 10s., though that is a substantial improvement on the opening price of the year. Lancashire bars of this quality are 5s. more. Makers of gas strip are also feeling the benefit of the diminished competition, and are realising appreciably higher prices as the result of the improved demand.

Steel.

In the absence of foreign competition—the total imports of semi-products last month, according to the Board of Trade returns, was not heavy—business in all sections of the home steel trade has shown a wonderful revival, the volume of inquiries being on an exceptionally heavy scale, with a very substantial percentage of orders materialising therefrom at enhanced prices. In the market for "semis" there is a strong demand for billets, both acid and basic, and it is with difficulty that all requirements can be met. Siemens acid billets are quoted £12, while soft basic qualities have risen to £9 10s., but hard and medium basic are unaltered at £10 5s. and £10 respectively. The inquiry for open-hearth steel is of increasing dimensions, and while much of the material is for home consumption, the amount for export is on a fairly heavy scale. But whilst the call for mild steel is so imperative, makers of crucible steel find business very slack. The Continent is taking scarcely anything, but fortunately there is a slight improvement as regards home and Colonial business, and if this continues business should bear a much brighter appearance before very long. Some encouraging business in railway steel is also reported. Business in ferro-manganese continues heavy, both for home and export, the recent advance not having any material effect on the demand. The makers are naturally inconvenienced in regard to coke supplies, and with the increasing costs it is not unlikely that a further upward move in values will shortly be decided upon. Consumers in many cases are clamouring for supplies, and a number of export inquiries from the Continent have had to be turned down. The tinplate market continues very strong, and plates are being done at 23s. basis, f.o.b. Welsh port. Makers, however, are not keen to sell in view of the prospect of a further advance in tinplate bars, and, consequently, tinplates. It is reported that some makers are asking 24s. basis, f.o.b., or 1s. 6d. per box above the fixed minimum. Several works are now off the market for the present.

Scrap.

Conditions in the principal markets for scrap iron and steel, though varying slightly in the matter of prices, continue the expansion in demand previously noted, the existing scarcity of new raw materials contributing to an increasing activity in this class of substitute metals. In most of the foundry districts the prices asked now for No. 3 iron range from 115s. to 125s. per ton; but good broken machinery cast scrap, which is really a foundry material superior to ordinary pig-iron, is selling only with difficulty at 95s. per ton. Many Lancashire ironfounders are now working on pig-iron, which costs them only about 92s. 6d. per ton, but they will very soon be working on iron which costs 115s. or even 120s. per ton, and then they will doubtless willingly pay 100s. or 105s. for scrap, and consider it cheap. On Tees-side there is a strong demand for most descriptions of iron and steel scrap, and though prices in the main are unchanged, there is a stronger tendency. Heavy steel scrap has, however, shown a tangible advance, it now being possible to realise 90s. per ton delivered. Heavy cast-iron scrap is firmer, and for fair good machinery quality approximately 100s. is being paid. Steel turnings and cast-iron borings are both quoted at 67s. 6d. per ton. There is a moderate inquiry for good piling qualities of heavy wrought iron at 90s. to 95s., and special heavy forge scrap is quoted in the region of 105s. per ton. All these are delivered prices.

Metals.

Copper.—The market for standard copper during the past week evidenced a steady tendency, with values again on the up grade, after a spell of buying on profit-taking account at an earlier period. Messrs. Henry Gardner & Co., Limited, state, however, in their weekly report, in view of the excellent consumption of copper during the last two months, there seems little possibility of any serious fall, but until a fresh buying movement starts there would appear no justification for any new rise in prices. Intense activity continues in the American manufacturing trades, and owing to the exceedingly heavy domestic takings of refined copper the reserve stocks of the latter are now comparatively light and are practically entirely in the hands of the two larger interests. Current quotations :—*Cash* : Wednesday, £73 12s. 6d.; Thursday, £74 5s.; Friday, £75 7s. 6d.; Monday, £76 5s.; Tuesday, £75 17s. 6d. *Three Months* : Wednesday, £74 2s. 6d.; Thursday, £74 17s. 6d.; Friday, £75 17s. 6d.; Monday, £77; Tuesday, £76 10s.

Tin.—Influenced by strong cable advices from the East, and favourable reports of American buying, the market for standard tin has developed exceptional strength during the past week, and values have advanced to a phenomenal level The demand from consumers has been fairly brisk, Welsh tinplate makers having placed good orders to cover their needs over the spring in view of the continued activity in this product, and the mills are now supplied with orders sufficient to carry them into May and even June. The further sharp rise which took place in the price of tinplates had a certain stimulating effect on the speculative demand for tin apart from the prospect of a heavy American consumption. The calls made upon Straits resources for some time past on American account have been so insistent as to place Eastern smelters in a more independent position. In fact the London market has become increasingly influenced by the comparatively high terms generally realised at the primary source. Current quotations :—*Cash* : Wednesday, £224 15s.; Thursday, £231 15s.; Friday, £232; Monday, £225 10s.; Tuesday, £222 17s. 6d. *Three Months* : Wednesday, £224 15s.; Thursday, £232 5s.; Friday, £232; Monday, £226 10s.; Tuesday, £223 10s.

Spelter.—Some irregularity has developed in the movement of this metal, a more liberal tonnage of Continental supplies being available, but later the market has recovered to some extent on the strength of repurchases by American interests. Current quotations :—*Ordinary* : Wednesday, £37; Thursday, £37 12s. 6d.; Friday, £37 15s.; Monday, £37 5s.; Tuesday, £37 7s. 6d.

Lead.—Values for soft foreign pig have weakened during the past few days, but the undertone remains firm. General conditions show but little change. Consumers continue to buy only to cover their immediate requirements. Current quotations : *Soft foreign (prompt)* : Wednesday, £28 12s. 6d.; Thursday, £28 17s. 6d.; Friday, £28 15s.; Monday, £28 15s.; Tuesday, £29.

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is the one that does the work and does it well with the minimum running cost. From the wide range of various designs of

Submit your Fan Problems to us.

Mechanical Boiler draught, Ventilation, Blowing Cupolas, Dust Removal, etc.

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Centrifugal Fans

we can select the right Fan for your purpose because we have a thorough knowledge of Fan applications, acquired by years of experience.

Your requirements are first carefully studied and the Fan then selected that will do the work efficiently through a long life of hard service.

DAVIDSON & CO., LIMITED,

Sirocco Engineering Works, BELFAST.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	75	17	6
Three months	76	10	0
Electrolytic	83	0	0
Tough	78	0	0
Best selected	78	0	0
Sheets	106	0	0
India	93	0	0
Wire bars	83	10	0
Do. Apr.	83	10	0
Do. May	83	10	0
Ingot bars	83	10	0
H.C. wire rods	87	10	0
Off. aver., cash, Feb.	67	15	3
Do. 3 mths., Feb.	68	9	6
Do. Settlement Feb.	67	15	1½
Do. Electro, Feb.	74	15	4½
Do. B.S., Feb.	72	6	3
Aver. spot price, copper, Feb.	67	14	3
Do. Electro, Feb.	75	0	9

Solid drawn tubes 14½d.
Brazed tubes 14½d.
Wire 11¾d.
Yellow metal rods 7½d.
Do. 4x4 Squares 9d.
Do. 4x3 Sheets 10d.

BRASS.

Solid drawn tubes 12¾d.
Brazed tubes 14d.
Rods, drawn 11½d.
Rods, extruded or rolled 7½d.
Sheets to 10 w.g. 11d.
Wire 11d.
Rolled metal 10½d.

TIN.

Standard cash	222	17	6
Three months	223	10	0
English	223	0	0
Bars	225	0	0
Chinese	222	10	0
Straits	230	10	0
Australian	227	0	0
Eastern	235	5	0
Banca	226	10	0
Off. aver., cash, Feb.	190	12	0¾
Do. 3 mths., Feb.	192	7	5½
Do. Sttlment, Feb.	190	11	4½
Aver., spot, Feb.	190	10	4½

SPELTER.

Ordinary	37	7	6
Remelted	34	15	0
Hard	29	10	0
Electro 99.9	43	10	0
English	38	0	0
India	31	10	0
Prime Western	38	0	0
Zinc dust	50	0	0
Zinc ashes	14	0	0
Off. aver., Feb.	35	8	9
Aver., spot, Feb.	35	12	2¼

LEAD.

Soft foreign ppt	29	0	0
English	30	0	0
Off. average, Feb.	28	6	5½
Average, spot, Feb.	28	10	4½

ZINC SHEETS, &c.

Zinc sheets, English	43	0	0
Do. V.M. ex whf.	42	0	0
Dutch	42	0	0
Rods	49	0	0
Boiler plates	41	0	0
Battery plates	42	0	0

ANTIMONY.

English regulus	30	10	0
Special brands	36	10	0
Chinese	27	10	0
Crude	20	0	0

QUICKSILVER.

Quicksilver, nominal 12 2 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% £12 7 6
75% £20 5 0
Ferro-vanadium—
35/40% 17/- lb. va.
Ferro-molybdenum
70/75% c. free 9/6 lb. mo
Ferro-titanium—
23/25%, carbonless 1/1 lb.
Ferro-phosphorus, 20/23%, £25
Ferro-tungsten—
80/85%, carbon free 1/5 lb.
Tungsten metal powder—
98/99% 1/10½ lb.
Ferro-chrome—
4/6% car. £22 10
6/8% car. £21 15
8/10% car. £21 0
Ferro-chrome—
Max. 2% car. £52 0
Max. 1% car. £62 0
Max. 0.70% car. £72 0
67/70%, carbonless 1/6½ lb.
Nickel—99%, cubes or pellets £130 0
Cobalt metal—98/99% 12/- lb.
Aluminium—98/99% £105
Metallic Chromium—
96/98% 4/6 lb.
Ferro-manganese (net)—
76/80%, loose £16
76/80%, packed £17
76/80%, export £16
Metallic manganese—
94/96%, carbonless 2/- lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ¾ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	4	17	6	5	15	0
Bundled steel & shrngs.	4	2	6	4	17	6
Mixed iron & steel	4	5	0	4	10	0
Heavy cast iron	4	2	6	4	5	0
Good machinery for foundries	4	5	0	4	10	0
Cleveland—						
Heavy steel				4	10	0
Steel turnings				3	7	6
Cast-iron borings				3	7	6
Heavy forge				5	5	0
Bushelled scrap				4	10	0
Cast-iron scrap				5	0	0
Lancashire—						
Cast-iron scrap				5	0	0
Heavy wrought				5	0	0
Steel turnings				3	12	6

London — Merchants' buying prices delivered yard.

Copper (clean)	67	0	0
Brass (clean)	40	0	0
Lead (less usual draft)	26	0	0
Tea lead	24	0	0
Zinc	26	0	0
New aluminium cuttings	67	0	0
Braziery copper	59	0	0
Gun metal	53	0	0
Hollow pewter	170	0	0
Shaped black pewter	100	0	0

PIG-IRON.

N. E. Coast—			
Foundry No. 1	132/6		
Foundry No. 3	127/6		
Forge No. 4	117/6		
Mottled	—		
Hematite No. 1	126/-		
Hematite M/Nos.	125/-		
Midlands—			
Staffs. common	—		
,, part-mine forge	—		
,, ,, foundry	—		
,, Cold blast, ord.	190/-		
,, ,, roll iron	200/-		
,, basic	—		
Northants forge	95/-		
,, foundry No. 3	105/-		
,, basic	105/-		
Derbyshire forge	97/6		
,, foundry No. 3	110/-		
,, basic	110/-		
Scotland—			
Foundry No. 1	125/-		
,, No. 3	120/-		
Hematite M/Nos.	130/-		
Sheffield (d/d district)—			
Derby forge	101/-		
,, foundry No. 3	113/6		
Lincs. forge	100/-		
,, foundry No. 3	105/-		
,, basic	120/-		
E.C. hematite	132/9		
W.C. hematite	136/3		
All d/d in the district.			
Lancashire (d/d eq. Man.) —			
Derby forge	—		
,, foundry No. 3	115/-		
Northants foundry No. 3	—		
Cleveland foundry No. 3	—		
Staffs. foundry No. 3	—		
Lincs. forge	—		
,, foundry No. 3	—		
Dalzell, No. 3	137/-		
Summerlee, No. 3	137/-		
Glengarnock, No. 3	137/-		
Gartsherrie, No. 3	137/-		
Monkland, No. 3	137/-		

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£11 10 to 12	10	0
Angles	12	5	0
Tees to 3 united ins.	12	10	0
Nut and bolt	11	10	0
Hoops	15	0	0
Marked bars (Staffs.)	14	0	0
Gas strip	£12/5 to 12	10	0
Bolts and nuts, ¾ in. × 4 in.	18	10	0
Steel—			
Ship plates	10	0	0
Boiler plates	14	0	0
Chequer plates	10	15	0
Angles	£9 10 0 to 10	0	0
Tees	£10 0 0 to 11	0	0
Channels	10	5	0
Joists	9	10	0
Rounds & squares 3 in. to 5½ in.	11	5	0
Rounds under 3 in. to ¾ in.	11	0	0
Flats, over 5 in. wide and up	11	10	0
Flats, 5 in. to 1½ in.	10	15	0
Rails, heavy	9	10	0
Fishplates	13	10	0
Hoops (Staffs.)	12	0	0
Black sheets, 24 g.	13	12	6
Galv. cor. sheets, 24 g.	£19 5 0 to 19	10	0
Galv. fencing wire, 8 g. plain	17	0	0
Rivets, ¾ in. dia.	13	15	0
Billets, soft	9 0 0 to 10	0	0
Billets, hard	9 5 0 to 10	5	0
Sheet bars	8 10 0 to 9	0	0
Tin bars	8	16	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 4
Sheet	1 4¾
Wire	1 5
Rods	1 3½
Tubes	1 7
Castings	1 2

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3¼ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	31.14
No. 2 foundry, Valley	30.00
No. 2 foundry, Birm.	26.00
Basic	30.46
Bessemer	30.77
Malleable	31.96
Grey forge	31.27
Ferro-manganese 80% delivered	110.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	42.50
O.-h. billets	42.50
O.-h. sheet bars	42.50
Wire rods	50.00
	Cents.
Iron bars, Phila.	2.57
Steel bars	2.35
Tank plates	2.35
Beams, etc.	2.35
Skelp, grooved steel	2.25
Skelp, sheared steel	2.25
Steel hoops	3.05
Sheets, black, No. 28	3.50
Sheets, galv., No. 28	4.60
Sheets, blue an'l'd, 9&10	2.65
Wire nails	2.80
Plain wire	2.65
Barbed wire, galv.	3.45
Tinplate, 100-lb. box	$4.95

COKE (at ovens).

Welsh foundry 40/- to 45/-
,, furnace 30/- to 35/-
Durham & North. fdy. 42/6
,, furnace 33/6
Other Districts, foundry 45/-
,, furnace 35/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	23/3
,,	28×20, ,,	47/6
,,	20×10, ,,	32/10½
,,	18¾×14, ,,	23/3
C.W.	20×14, ,,	21/9
,,	28×20, ,,	43/9
,,	20×10, ,,	29/9
,,	18¾×14, ,,	21/9
Ternes. f.o.t.	28×20, ,,	43/9

TUBES.

	Up to and incl. 6 in.	
Gas ..	..57½%	Tube prices
Water	..52½%	are
Steam	..47½%	now free.

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.	
Rolled Ordinary—Assortment ..	17 0 0	to
Nail Rods—Square, round and flats ..	17 10 0	

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—Single welded .. £10 to £11

Billets—Single and double welded .. .. £13 to £14

Pig-iron—Grey, white or mottled £6 10 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Mar. 14	73	12	6	inc.	22/6
„ 15	74	5	0	„	12/6
„ 16	75	7	6	„	22/6
„ 19	76	5	0	„	17/6
„ 20	75	17	6	dec.	7/6

Electrolytic Copper.

Mar. 14	80	15	0	inc.	5/-
„ 15	81	15	0	„	20/-
„ 16	82	10	0	„	15/-
„ 19	83	0	0	„	10/-
„ 20	83	0	0	No change	

Standard Tin (cash).

Mar. 14	224	15	0	dec.	190/-
„ 15	231	15	0	inc.	140/-
„ 16	232	0	0	„	5/-
„ 19	225	10	0	dec.	130/-
„ 20	222	17	6	„	52/6

Tin (English ingots).

Mar. 14	225	10	0	dec.	190/-
„ 15	232	0	0	inc.	130/-
„ 16	232	0	0	No change	
„ 19	226	0	0	dec.	120/-
„ 20	223	0	0	„	60/-

Zinc Sheets (English).

Mar. 14	43	0	0	No change	
„ 15	43	0	0	„	
„ 16	43	0	0	„	
„ 19	43	0	0	„	
„ 20	43	0	0	„	

Spelter (ordinary).

Mar. 14	37	0	0	inc.	2/6
„ 15	37	12	6	„	12/6
„ 16	37	15	0	„	2/6
„ 19	37	5	0	dec.	10/-
„ 20	37	7	6	inc.	2/6

Lead (English).

Mar. 14	30	0	0	dec.	5/-
„ 15	30	0	0	No change	
„ 16	30	0	0	„	
„ 19	30	0	0	„	
„ 20	30	0	0	„	

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1885	44 0	44 1	43 2	43 1	42 10	42 6	42 6	42 0	42 2	42 1	43 0	43 8	42 11½
1886	43 3½	42 0	42 0	41 6½	41 2½	40 0	40 0	41 2½	41 6	44 0	44 0	44 9	42 2½
1887	49 6	48 9½	45 6	43 2½	43 6½	44 1	44 0	44 2½	43 5½	41 6	41 9½	45 0	44 6½
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	49 10½	48 8½	46 10	46 1½	48 2½
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	284 0	11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½

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